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STEAM GENERATION
POWER GENERATION
WATER POWER
DIESEL & GAS ENGINES
AIR CONDITIONING & HEATING
REFRIGERATION
PUMPS & COMPRESSORS
STEAM SERVICES
ELECTRICITY & ELEVATORS
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MECHANICAL TRANSMISSION
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AUGUST, 1937

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POWER

A McGRAW-HILL PUBLICATION — ESTABLISHED 1882 — PHILIP W. SWAIN, EDITOR

Engineers' Weather

AT LAST something is being done about the weather, and in a big way! In a single year utility air-conditioning loads have increased more than 100 per cent. The public demands controlled atmosphere, and the engineer delivers the goods.

Thousands of *Power's* readers have become nursemaids to air-conditioning systems in factories, hotels, theaters, office and public buildings, stores, institutions. For other thousands the same responsibility is right around the corner. From now on the engineer must be the weather man and he must take the kicks.

In April, 1936, *Power* set out to take the mystery from air conditioning by an A, B, C presentation of the fundamentals and by proving that 90 per cent of these processes have already been mastered by the power engineer through his long experience with heating, piping, refrigeration, ventilation, washing, controls.

As a guide to further service the editors have been seeking the "low-down" on air conditioning from those who know the field intimately. Let's see now how these men answer certain questions which thousands of engineers are asking:

1. Is all this hullabaloo in the popular press just "hot air," or will air conditioning be the biggest development of the next decade? The development will be tremendous, possibly greater than that in any other line.

2. Will practically every home be completely air conditioned within the next ten years? Almost certainly not; too costly. However, complete air conditioning may become fairly common in the homes of the prosperous.

3. What about the air conditioning of stores, buildings, institutions, theaters and other places where the public is served? Complete air conditioning will become standard practice for the "nice places" in all sections of the country where at least 30 days yearly are uncomfortably hot and another 30 days uncomfortably cold.

4. How about factories? Applications will increase rapidly wherever product requires special conditions of humidity, temperature, cleanliness and air motion. If the level of national prosperity can support the cost, comfort air conditioning also will make substantial progress in factories, particularly in hot climates.

5. Will water supplies, water systems and sewer systems be able to handle the cooling load? Not if we continue to remove only a few thermal units per pound of water. Air conditioners in most districts must eventually turn to cooling towers or other methods of dissipating heat with a minimum of water waste. Even at that, cities will be forced to increase greatly their water supplies and water-handling capacity.

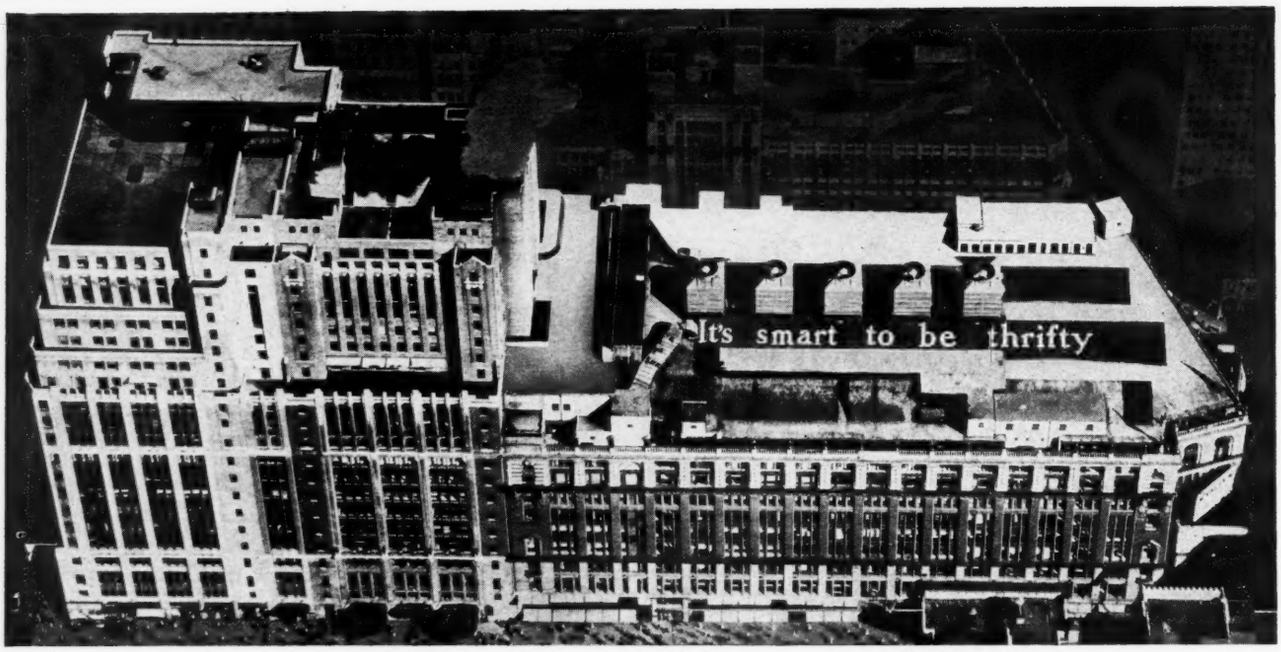
6. Is it essential that every engineer managing the power services of a factory, building or institution master air conditioning immediately? Yes, absolutely.

7. What must he study in an engineering way? Polish up his existing knowledge of heating, ventilating, refrigeration, fans, controls, etc. Learn the exact meaning and use of "dry bulb," "wet bulb," "relative humidity," "effective temperature," "psychrometric chart," "comfort zone," etc. Study actual air-conditioning equipment.

8. Will a complete knowledge of how to produce any specified temperature, humidity and air motion make one a practical air-conditioning engineer? Absolutely no, because weather preference is a personal matter—one man's meat is another's poison. Because blue-blooded old ladies refuse to wear red flannels and red-blooded athletes often wear heavy suits and the two sometimes patronize the same places. Because crowds generally include old and young, sick and well. Because some come from the torrid street to stay for an hour or so, while others rush in and out. And so on.

The practical air-conditioning engineer must therefore add to his technical skill the wiles of the witch doctor. He must everlastingly study his people. He must balance the "too hot" kicks against the "too cold." He must serve his particular average clientele and at the same time diplomatically educate the cold blooded and the hot blooded to dress to suit his average "good weather."

We talk a lot about "human engineering." Now we've got to apply it. Every "weather man" now must be a diplomat as well as an engineer.



Just back of Macy's motto "It's smart to be thrifty," are the five towers that cool condensing water for the mixed-pressure and two low-pressure turbines

Macy's Installs Another Diesel

Addition of a 700-kw. diesel will bring plant capacity to 6,450 kw., not including 1,720 hp. of steam turbines driving refrigerating compressors. Last year, over 20,000,000 kw. hr. were generated at a cost of 1 cent per kw. hr., and nearly 500,000,000 lb. of steam were produced at 41.55 cents per lb. With a power increase of 170% in 13 years, fuel-oil consumption increased only about 63%

R. H. Macy's department store occupies the block bounded by Broadway, Seventh Avenue, 34th and 35th Streets, New York City. This building, with 2,041,335 sq.ft. of floor area, is not only the home of the world's largest retail merchandising establishment, but has one of the most interesting modern power plants found anywhere. It is the largest privately owned power plant in New York City and the largest of its kind in the world. Its primary power units include steam engines, a high-pressure turbine exhausting at 2-lb. gage back-pressure; two low-pressure and a mixed-pressure turbine operating condensing; and two diesel engines; also 11 oil-fired boilers, a 1,600-ton steam-turbine-driven refrigerating plant for air conditioning, a 110-ton motor-driven refrigerating plant for general service, a large cooling-tower installation and a wide variety of other equipment to provide necessities and conveniences required in an up-to-the-minute merchandising business.

Another very interesting and important feature about this power plant is that it is operated as an integral part of the business and not as something alien to it. For the space that the plant occupies, it is one of the best paying departments in the store, when compared with other means of supplying power and steam. Company executives realize that the power plant can be a source of profit or loss, the same as a department in the store. Therefore, they are just as careful to have it as well operated, and an annual report on the power-plant's operation is as important to them as that of the largest merchandising department.

Plant Records

A very complete record is made of plant operation and these data presented in daily, monthly and yearly form to give to the engineers a picture of performance. Fig. 1 is one of these charts. The top curve is a total monthly kilowatt-hour curve. Up until June, 1930, all power was generated by steam, when the diesel engines went into service. From then the cross-sectioned area shows power generated by these engines. In the middle of 1933 the mixed-pressure steam turbine came on the system, and from there the bottom cross-sectioned area shows power generated by this unit. The area below the cross-section represents power generated by the steam engines, which shows that these engines are now supplying more load than before the diesels and turbine were installed. The other curves clearly indicate operating conditions and costs and give at a glance an accurate picture of plant performance.

This power plant has undergone a process of continual expansion for the last 15 years to keep pace with a rapidly growing business and meet demands for a greatly increased use of power in merchandising. All through this development it has been given very careful engineering study, both by consulting engineers and by Macy's engineering staff. Every change in the plant has been made only after an exhaustive study has shown it to be more economical than any other means of providing the service.

The increased use of power in merchandising has created demands not dreamed of 15 years ago. These are due to greatly improved illumination, better ventilation, air conditioning of a large part of the store, improved elevator and escalator service and other conveniences. How these have affected the power load is clearly evident from the two top curves,

Fig. 2. In 1924, for 1,550,000 sq.ft. of floor area, power consumption was 7,535,933 kw.hr., or 4.86 kw.hr. per year per sq.ft. of floor area. Power consumption in 1936 increased to 20,166,640 kw.hr., which for 2,041,335 sq.ft. floor area is approximately 10 kw.hr. per year per sq.ft. of floor area, more than double that for 1924. The latter does not give a true picture, because the air-conditioning compressors are driven by steam turbines. If these compressors were driven electrically they would add about 1,000,000 kw.hr. of load and raise the power per year per square foot of floor area to 10.5 kw.hr.

Thermal Efficiency

The curves, Fig. 2, show very clearly how the thermal efficiency of the plant has been improved as new equipment has been added, at the same time retaining the original units. From 1924 to 1936, inclusive, power load increased 160%, but fuel oil used increased 63%. Steam for operating the air-conditioning system is included in this, so that a truer picture would be to consider that power increased around 170% with only a 63% increase in fuel oil. If the fuel oil used in 1936 had been in proportion to that in 1924, approximately 4,000,000 gal. more would have been required. Such an increase would make economic operation questionable.

On the curves, Fig. 2, are indicated the equipment that has been added from time to time to meet increased load. The small increase in fuel oil for the large increase in power output pays high tribute to sound engineering judgment in selecting this equipment and the high efficiency at which it has been operated.

Daily Load

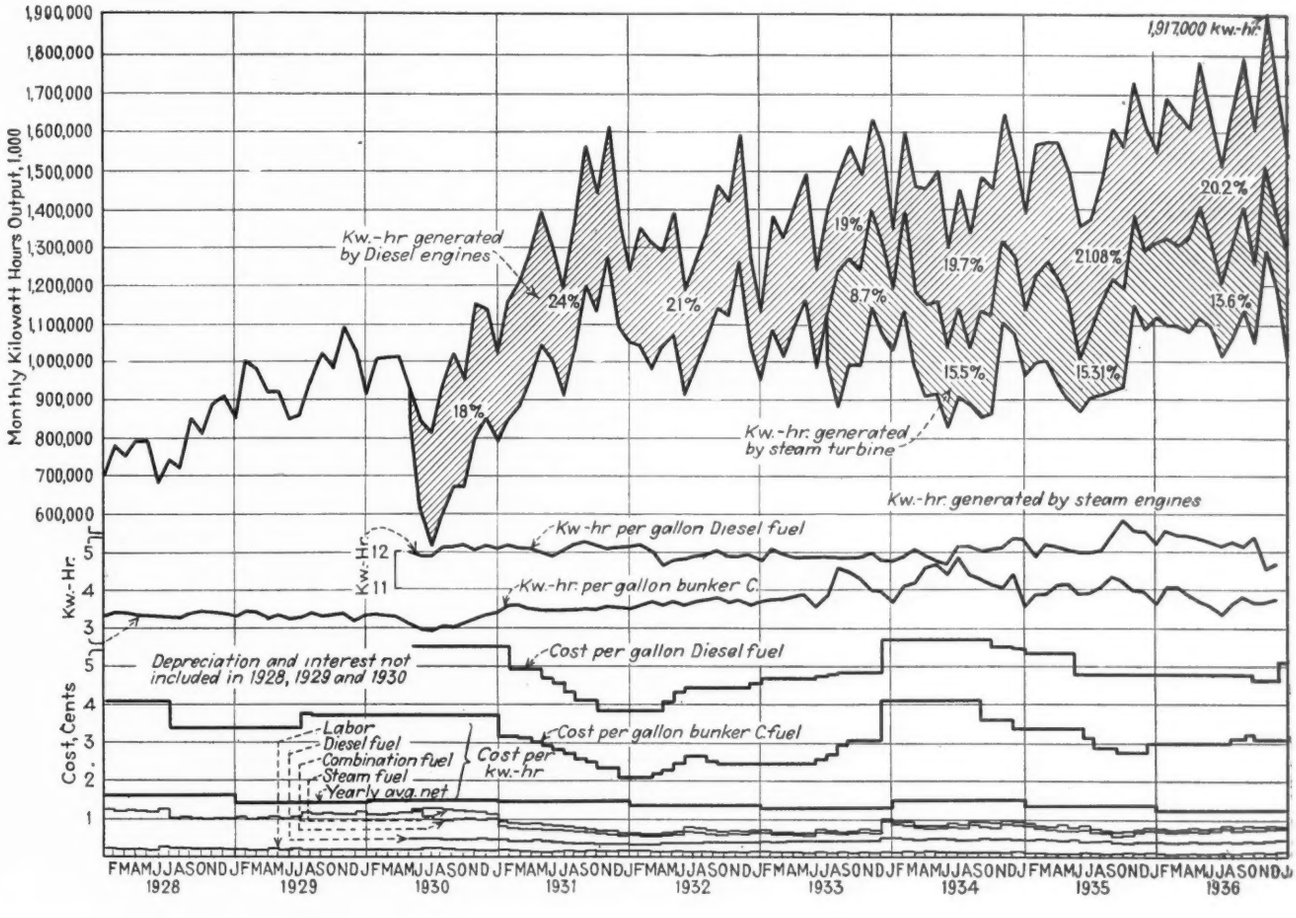
Fig. 3 shows a daily kilowatt-load curve for three different years, for a day in June, as plotted from hourly readings. While the store is open, load remains practically constant from 9 a.m. until 5 p.m. The curve for June 10, 1937, is for a day when the store was open until 9 p.m. This, however, does not change the shape of the curve, except to widen the peak. The plant is now operating with all power units in service when the store is open, carrying practically the maximum load that it is considered safe for continuous operation.

The present power plant, which has a total capacity of 5,750 kw., is an outgrowth of the coal-fired, 2,000-kw., steam-engine plant of 1920, with large steam pumps for the hydraulic elevators. After an exhaustive study at that time by two firms of consulting engineers, Kaiser Muller & Davies and Werner Nygren, it was decided to enlarge the power plant. First the boilers were changed from coal- to oil-firing. To increase power-driven generating capacity, two 200-kw., 110-volt, piston-valve-engine-driven generators were replaced by a 250-kw. and a 750-kw., 250-volt generator, each driven by a Corliss engine. As part of this program, four 400-kw., 110-volt Corliss-engine-driven generators were rewound for 250 volts and the distribution system changed for 3-wire, using balancer motor-generators to provide the neutral of the 3-wire system.

At that time 26 hydraulic elevators in the older part of the store were supplied by two steam-driven pumps. Changing to motor-driven centrifugal pumps provided space for another 750-kw. Corliss-engine-driven unit. In 1928 it was decided to air-condition the basement and ground floor of the store during hot weather. Two 410-hp. exhaust-steam-turbine-driven refrigerating compressors were installed for this purpose. These turbines exhaust into surface condensers at a vacuum of about 26 in. For several years condensing water was taken from city mains and discharged to the sewer, water first passing through condensers of the refrigerating plant before going to the condensers of the turbines.

In 1929, plans were made to extend the store over the entire block, making more power capacity necessary. At that time all hydraulic elevators

Fig. 1—Kilowatt-hour and cost curves from 1929 to 1936, inclusive



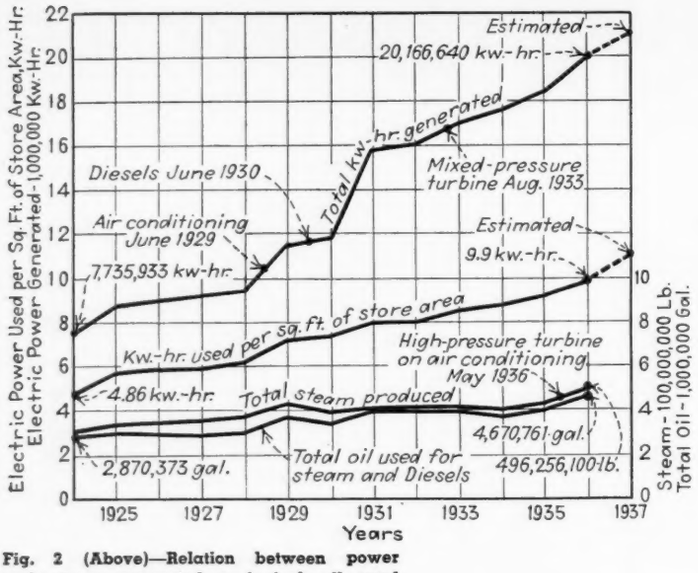


Fig. 2 (Above)—Relation between power and steam generated and fuel oil used

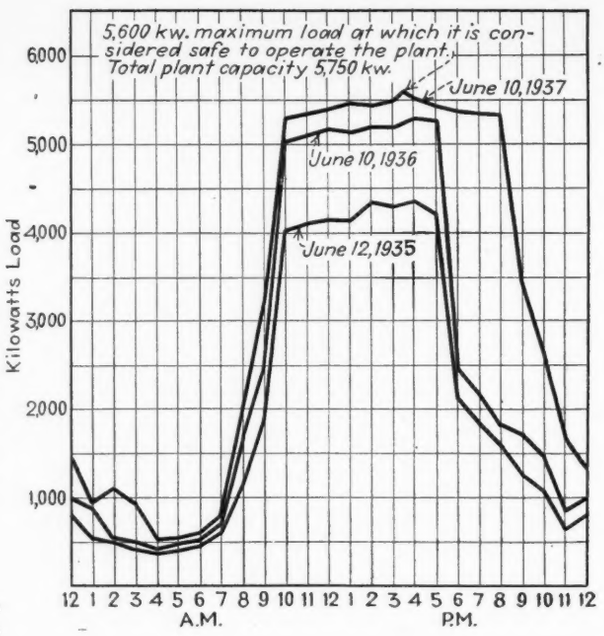

5,600 kw. maximum load at which it is considered safe to operate the plant.
Total plant capacity 5,750 kw.
June 10, 1937
June 10, 1936
June 12, 1935
Kilowatts Load
A.M.
P.M.

Fig. 3 (Right)—Typical daily load curves for three years, taken on the dates given

were replaced by electric ones. Removal of elevator pumps and surge tanks provided space for two 1,000-hp. diesel engines driving 700-kw. generators, giving a total plant capacity of 4,750 kw.

Power demands continued to increase, and by 1933 it was necessary to provide more generating capacity. By this time changes in New York City Building Code permitted cooling towers to be installed on the roof of the older part of the store. A study by the company's consulting engineers showed that an addition to the power supply could be provided most economically by installing a 1,000-kw. mixed-pressure steam-turbine exhausting to a surface condenser, provided with circulating water from cooling towers on the store roof. This turbine brought the usable capacity of the plant to 5,750 kw., and made it possible to use a large part of exhaust from the steam engines for power generation or heating at all times. When the turbine was installed, cooling towers were also provided for the two 410-hp. turbines driving the air-conditioning refrigerating compressors. This saved water, costing about $10,000 per year, that was formerly discharged to the sewers.

In 1936, the air-conditioning system was extended to include the second, third and fourth floors. To provide refrigerating capacity for this, a 900-hp. turbine-driven compressor was installed. This turbine operates on high-pressure steam and exhausts into the low-pressure header.

Adding the new air-conditioning unit increased power capacity of the plant to 9,400 hp. All increases up to this time were made without going outside the walls of the original power plant, which had a capacity of 2,700 hp., not including the hydraulic-elevator pumping engines. Steam and power loads continued to grow until in 1936 496,256,100 lb. of steam were produced, and 20,166,640 kw.hr. generated.

An approximate heat-balance diagram for last year's operation is shown in Fig. 4. All high-pressure steam is metered, therefore, these quantities are known accurately. Low-pressure steam quantities are estimated, but these estimates have been made so many times, both by the plant and the consulting engineers, and checked in various ways, they are also fairly accurate. The turbines absorb over 100,000,000 lb. of exhaust steam that would go to the atmosphere and provide 120,000,000 lb. of feedwater that would have to be purchased, without the condensing equipment.

Last Year's Load

Last year's load permitted operating the plant with only a 250-kw. unit in reserve, a condition that requires the highest quality of operation for safety. Even then the reserve was too small to permit a major overhaul job being done comfortably on a large unit. It was also evident that power load would increase, an assumption that has already proved correct. As shown by Fig. 3, on June 10 the load reached 5,600 kw., the maximum load considered safe for the plant with all generating equipment in service.

Last year's load conditions made it necessary to provide more power capacity. Kaiser, Muller & Davies were employed as consulting engineers to study the problem and report on how this could be most economically done. The consulting engineers have made their report, and on the basis of their conclusions it has been decided to install a new 1,000-hp. diesel engine, which will bring the total capacity of primary power equipment in the plant up to 10,400 hp. This report includes six different studies:

1. Cost of steam and electricity produced by Macy's power plant in 1936. This study shows that steam was produced for 42.55c. per 1,000 lb. when no credit was given for steam sold to tenants in the building. When credit is taken for this item the cost is 41.55c. This cost included all operating charges even to $9,627 rental and $19,566 for interest and depreciation on the boiler-plant equipment. The latter is certainly liberal, as a large part of the boiler equipment is over 35 yr. old. Space occupied by the boiler room, which is in the subbasement, is charged for at 58c. per sq.ft. per year.

Power-generating costs by the combined steam and diesel plant amounted to 1.496c per kw.hr. This cost includes $73,000 for interest and depreciation and $18,000 rental for the space occupied by the boiler and generating plant, but without taking credit for steam used for building and water heating and air-conditioning. When proper steam credits are taken, power-generating cost drops to 1.018c. per kw.hr.

2. A study was made of generating all steam required for building heating, water heating, air-conditioning turbines, house pumps, kitchens, etc., and purchasing all electric power. This study shows that the total cost of generating steam and purchasing electricity, including all charges, would be $464,700, or 2.33c. per kw.hr., compared to $297,951, or

1.496c. per kw.hr. in 1936 for generating power and steam in Macy's power plant. The saving in favor of operating the power plant is $166,749.

In the charges for purchased electricity are included $53,000 interest and depreciation, the same as charged against the present power-generating equipment. These charges are justified, since if the steam-engine and diesel plants were discontinued they cannot earn profits to retire the investment as they are now doing. Consequently, interest and depreciation set aside previously should be charged against the cost of purchased power each year, until investment in equipment replaced has been amortized.

Charged against purchased power are also $16,000 for interest, depreciation, taxes and insurance on conversion equipment to convert 50% of the power into direct current for motors, it being assumed that 50% of the power would be used for lighting as alternating current. Other charges included are $12,741 for losses in the conversion apparatus and $2,900 for rental of space it would occupy.

3. The installation of a 1,000-hp. diesel engine driving a 700-kw. generator was investigated as another possibility. On the basis of the 1936-load conditions, this engine would be a flat charge of $11,382 against 1936 operating costs and would raise the total charges to $309,333, making a total cost of 1.552 c. per kw.hr. generated, and 1.074c when proper credit is given for other services rendered by the plant.

4. A third possibility investigated was to generate all steam and electricity required for the store, except electric power, 3,051,800 kw.hr. for the 7th Ave. building, which was to be purchased. The estimates show a total cost of $330,813, or 1.66c. per kw.hr., based on 1936-load requirements. Because the diesel engines are more economical than the steam engines when there is excess exhaust, it has been assumed that they will generate as much of load as possible.

5. A study was made for conditions similar to 4, but assuming an 8% increase in power consumption over 1936. This showed a total cost of $347,422.

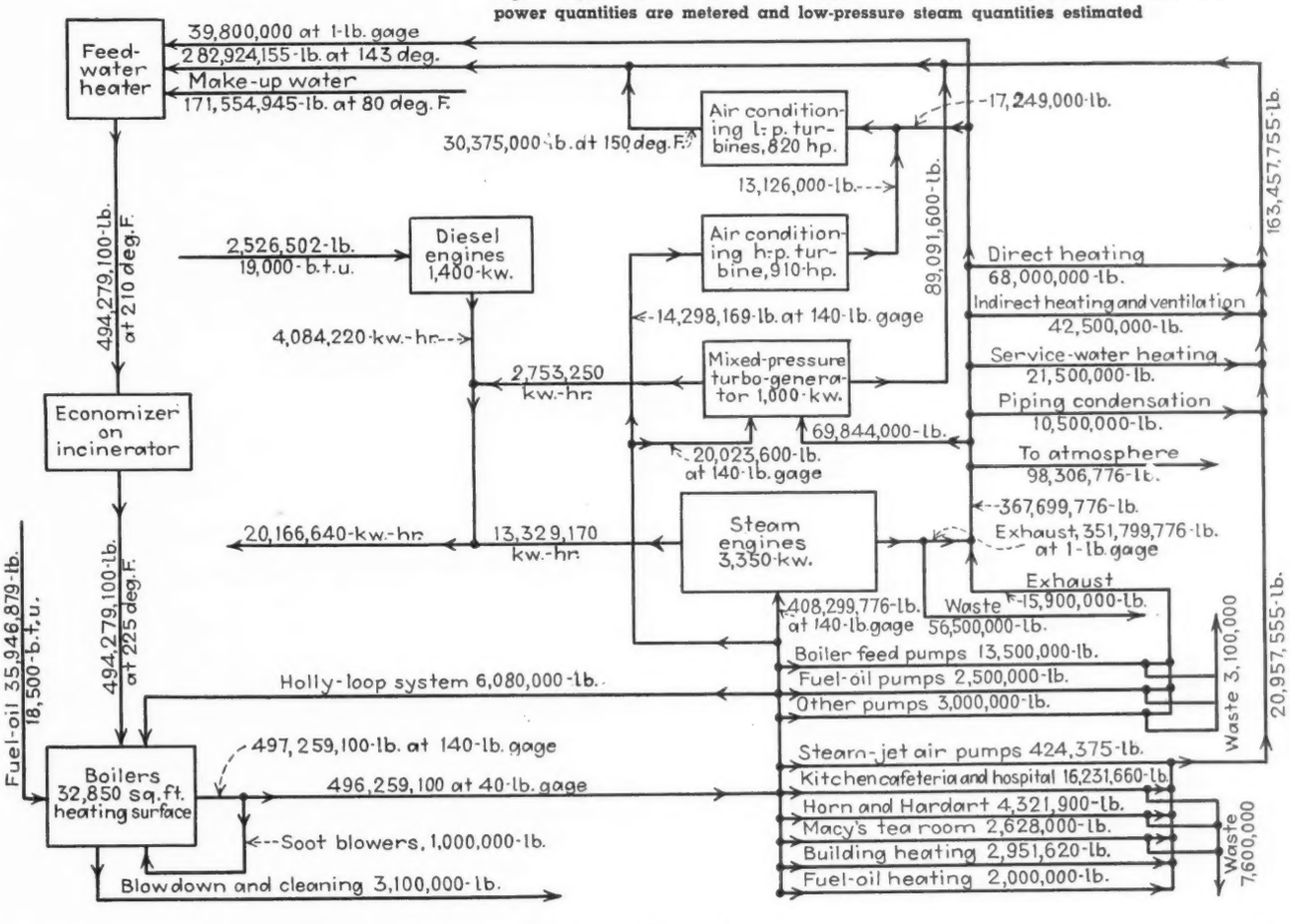
6. The concluding study assumed all power generated, but with an 8% increase in power over 1936. Under these conditions the total cost of operation will be $317,670, or $29,752 less than if power were purchased for the 7th Ave. building. This saving will pay the total cost of the new generating unit and its installation in about 3.25 years. Accordingly, a McIntosh & Seymour, 1,000-hp., 600-r.p.m., 4-cycle diesel engine directly connected to a 700-kw., 250-volt Crocker-Wheeler generator has been purchased.

Location of New Unit

All available space in the power-plant room was taken when the 1,000-kw. mixed-pressure turbine was installed, so that the new diesel will be installed in the basement of the 7th Ave. building. This building is served from a switchboard in its basement, connected by feeders to steam power-plant switchboard. The new generating unit will be near the 7th-Ave. building switchboard, connected to its busbars, and operate in parallel with the other units. This arrangement will be highly satisfactory, as it will save part of the power losses that now occur between the two switchboards, improve voltage regulation in the 7th Ave. building and provides space to install another 700-kw. diesel unit when required. The unit is now being installed and is expected to go into service in September.

For assistance in writing this article acknowledgment is made to John J. Cogan, assistant general manager, D. J. Creeden, chief engineer, and Roy Swanson, power-plant statistician for Macy's, and to Kaiser, Muller & Davies, consulting engineers.

Fig. 4—Approximate heat-balance diagram for 1936. All high-pressure steam and power quantities are metered and low-pressure steam quantities estimated



TO TOP OR NOT TO TOP

"It all depends," says this authority on tops and many other power matters. He shows where superposition pays and where it doesn't

By Frank S. Clark
Consulting Engineer, Stone & Webster Engrg. Corp.

TO TOP or not to top—that is the question. The title of this paper, which the Editor of *Power* suggested to me, naturally leads to an attempt to paraphrase Shakespeare, but the choice of whether to top or not to top is more difficult than the one which faced Hamlet. We may "take arms against a sea of troubles," but there is little hope that we can "by opposing, end them."

The power-producing industry, both utility and industrial, is experiencing a wave of "superposition" or "topping." After a 5-year period of practical stagnation in capacity additions, rapid increase in electric load and industrial activity has afforded the opportunity for this type of installation, which has been given added attractiveness by the higher steam temperatures and pressures that metallurgical research has made feasible. The utility or industrial executive and engineer, faced today with the necessity for providing additional power-producing facilities, cannot overlook this method of meeting his requirements. The answer, however, is not self-evident, and "topping" may or may not be the solution.

A recent subcommittee report of the Edison Electric Institute defines topping as "the placing of one heat cycle upon another." This may be a cycle using steam at high pressure and temperature, or one using some other vapor, of which only mercury has been used commercially so far. Assuming the cycle to be steam, this vapor, after completing its work in the superposed cycle, is available for production of power in the lower cycle or may be used, in the case of some industrials, in various manufacturing processes requiring large amounts of heat.

Topping accomplishes two things: it adds power-producing capacity, and it increases the efficiency of power production. Capacity is obtained by increased pressure and temperature range, and efficiency is increased for the same reason and also by the use of modern heat-liberating, absorbing and utilization equipment. It might be added, however, that efficiency of heat liberation and absorption is independent of steam temperature and pressure and can be attained, if desirable, with modern equipment under any pressure and temperature. It is, therefore, only an associate of topping.

Power-generating capacities of the usual utility property consist of a number of individual installations made successively as required by load increases. Sometimes the additions are made to one plant until lot area is completely utilized, or distribution of load requires that another power-producing center be established. Again, they may be made to several plants on a system. Sometimes interconnection arrests growth of a plant in favor of a large so-called "superpower" station. Each addition, however, represents the state of the art as of the date it was made, applied to obtain the best economy, and is usually superior in efficiency to those previously made. This means that the newest equipment is operated on the base portion of the load curve and at a high capacity factor. Older units are pushed farther up on the load curve and run at lower outputs, or held simply as standby.

Capacity

In the case of a condensing-turbine installation, capacity is usually made equal to or greater than that of the largest unit on the system. This is done to provide relay capacity and to secure the advantages of lower unit investment cost. A topping unit's capacity is governed by the relation of the sum of the topping and topped capacity to the system load curve, and the capacity of the topping unit alone is usually less than that of a condensing turbine that would be installed as an alternative. Consequently it does not provide for load growth over so long a period, and while it may relegate some of the older units to lower use-factor operation, it brings others back into the base portion of the load.

In considering the two types of installation therefore, rate of load growth must be taken into account in the light of its effect on the length of time between successive installations. If growth is rapid, capacity added by topping may be used up by the time the unit is in operation, and it may be more advantageous to make the addition in the form of a larger condensing turbine. This type of installation will have the advantage of a better heat-utilization rate due to two reasons. In a topped installation, units topped being of an earlier vintage, will be less efficient than that portion of a modern condensing turbine which operates through the same pressure range. Also, the older units may not be capable of steam extraction for feedwater heating on the regenerative cycle. Their auxiliaries may, many of them, be steam driven. These facts impose more or less restrictions on the selection of the most desirable heat balance. These restrictions are not encoun-

Frank S. Clark began to hear about kilowatts and boilers shortly after he heard the waters of the Mississippi roll by at New Orleans, where he was born 55 years ago. At an early age he moved to Philadelphia, Pa., where his father was connected with United Gas Improvement Co. In 1901 Mr. Clark was graduated from Pennsylvania Military College with a degree in Civil Engineering followed up with three years at the University of Pennsylvania, where he received a degree in Mechanical Engineering.

After college, 8 years with a group of traction interests in Ohio and Indiana, first in the shops and car barns, then at the drafting board, afterwards on construction of steam power stations. 1912 to 1919, Mr. Clark was an engineer in the Mechanical Division, Stone & Webster. In 1919, he was made Mechanical Engineer in charge of Mechanical Work, and in 1926 Consulting Engineer.

During the past 25 years, he has been connected with the design and installation of about 1,500,000 kw. of steam-generating capacity, and has visited power plants involving a total capacity of about 10,500,000 kw.

Affiliations and memberships include: Prime Movers Committee of the N.E.L.A. and its successor, the Edison Electrical Institute; Power Generation Committee of the Association of Edison Illuminating Cos., of which he is now vice-chairman, and the Boiler Code Committee of the A.S.M.E.

tered in the installation of a new condensing unit where there is freedom of choice in regard to the number and pressures of bleed points and in the selection of drives for auxiliaries. In some topped installations, these restrictions have been overcome to a greater or less degree by use of steam-driven auxiliaries taking steam either direct from the high-pressure boiler or from the exhaust of the topping unit, and exhausting into feedwater heaters at suitable pressures. However, unless the topped units can be bled, the usual heat balance for a topping installation will be found to have no means of heating feed water at temperatures between 212 F and that corresponding to the saturation temperature of exhaust from the topped unit.

Temperature and Pressure

Capacity that it is possible to add by superposition depends upon pressure and temperature of the steam to the units that are being topped and the top pressure and temperature selected. A few installations have been made at top pressures of 650 lb., but the majority have so far been restricted to two groups; the first using pressures between 825 and 900 lb., with temperatures of 825 to 850 F, and the second using pressures of 1,200 to 1,425 lb. and temperatures of 900 to 925 F. The choice between these two groups depends upon existing steam conditions and the ratio of top to topped capacity that is desired, or can be proved economical, and this in turn ties back into the capacity factor at which the combination can be operated.

Exceptions to this are the large systems whose base loads permit topping up to the largest capacity of single units obtainable, at present about 66,600 kva. To my knowledge, no 850-lb. topping unit has been installed where the existing steam pressure exceeds 225 lb., capacity and economy increments being too small. A large number of 1,250- to 1,450-lb. units are on order for stations with existing pressures of 200 to 340 lb., the latter being the highest which has been topped to date.

Figs. 1 and 2 indicate approximately station heat rates and capacity increases which may be expected as the result of adding tops to existing plants operating at pressures between 200 and 400 lb. The cases considered include units of various sizes, taking into account variation in turbine efficiency which may be expected for plants of various ages as well as some variation in operating conditions. The range of conditions might be expected for the more common cases. Special conditions would increase the range. For example, capacity of the top for a given existing turbine may be increased considerably if some sacrifice in heat consumption is justified. Such variations require detailed studies of equipment and load characteristics. An efficiency of heat generation and absorption of 85% has been assumed for all cases represented by the curves of efficiency.

Fig. 1 applies to 850-lb. tops. Since initial steam conditions of 850 lb. and 900 F at the top throttle may result in temperatures which are excessive for existing low-pressure units of early designs, curves are included to indicate results for initial conditions of 850 lb. and 800 F.

Thus, Line 1 on this chart shows station heat rates for tops with an initial steam temperature of 800 F for the smaller existing units of early design and operating under the less favorable conditions as regards station losses.

Line 4 shows station heat rates estimated for initial steam conditions of 850 lb. and 900 F at the top as applied to large units of recent design operating under favorable conditions of station design and management.

The cross-hatched area between Lines 1 and 4 therefore represents the range of station heat rates estimated for topping cycles corresponding to cases which may commonly be expected.

Line 3

Line 3 is similar to Line 4 except that the inlet steam conditions are 850 lb., 800 F at the top throttle. The vertical distance between Lines 3 and 4 is therefore an index of the change in station heat rate corresponding to a change of 100 F in the inlet-steam temperature of the top.

Lines 2 and 5 are added by way of comparison to show the estimated station heat rates for new condensing installations of modern design for an initial steam condition of 850 lb. and 900 F (independent of the pressure of the existing station). Capacities of these installations have been assumed in each case to be the same as that of the combined topping and topped units. Line 2 applies to smaller units and is therefore somewhat comparable to topping cycle represented by Line 1. Line 5 applies to the larger units and may be compared with Line 4. The stippled area between Lines 2 and 5 represents the range of station heat rates for new condensing plants and may be compared with the cross-hatched area between Lines 1 and 4 which indicates the range of heat rates for topping cycles.

Similarly, Fig. 2 indicates station heat rates and capacity increases obtainable with 1,200-lb. tops through a range of conditions similar to that used for Fig. 1. Since an initial steam temperature of 900 F gives temperatures at the low-pressure turbine inlet which are not excessive, curves for an initial steam temperature of 800 F are not included on this chart.

The cross-hatched areas between Lines 6 and 8, Fig. 1, and 5 and 6, Fig. 2, indicate approximately ranges of expectable capacity increases expressed in percentages of capacities topped. In Fig. 1, Lines 6 and 7 correspond with 4 and 3, and Line 8 with Line 1. In Fig. 2, Lines 5 and 6 go with 3 and 1 respectively.

Not Economy Alone

In the utility property only rarely can one make out a case for topping on the basis of economy alone, although I know of at least one exception, in which case load growth has not required any addition to capacity in 15 years. When capacity is required, however, the situation is changed, and the engineer and executive are faced with the problem of topping or making a condensing installation.

In the industrial field, the situation is much the same as with the utility for those plants in which power load is predominant and where little or no process steam is required. Shapes of load curves and capacity factors, however, may be different. The extent to which topping may prove economical depends on the type, age, and total capacity of the existing steam-electric generating equipment and the capacity increment that is required. In some instances equipment, particularly boilers, may have served its useful life or be so old as to be of economic use only as standby. Also, some form of prime mover may have been used which is not capable of being topped, for instance, large gas engines in steel mills.

Industrial Plants

In those industrial plants requiring a large amount of process steam the problem becomes more complicated. Besides the effects of load factors of both electric power and steam for process, the amount of power obtainable from process steam, its percentage of the total power required and its degree of coincidence with the plant power-load curve have a distinct bearing. If the topping unit utilizes only the steam for process, its output follows necessarily the curve of the steam demand. This may be more or less than the total power requirements. If it is less than the minimum of such demand and there is sufficient installed low pressure generating capacity, which, in combination with the topping unit, will furnish the deficiency

in capacity, a size of top may be selected which will prove economical. If there is always an excess of steam over electric requirements, this must be supplied either through reducing valves or from existing low-pressure steam-generating equipment. If the excess is a large amount, it may possibly be used to generate power for sale to some utility system. Conditions vary and it is dangerous to draw any hard and fast conclusions.

Character of Water

In cases where direct use of process steam forces the use of a large percentage of feedwater makeup, character of the water may affect selection of a top pressure. Feedwater treatment becomes more difficult as higher pressures are used and may well dictate adoption of a lower pressure than would otherwise be indicated. In some instances, evaporators have been used to overcome this difficulty. Because of installation cost and their relatively high heat drop, evaporators are economical only in exceptional cases. Industrial practice generally has been to limit top pressure to the neighborhood of 700 lb. I know of only four industrial plants where a pressure as high as 1,200 lb. has been used for power generation at high back pressure, and in all of these installations evaporators have been used to avoid feeding the high-pressure boilers with treated makeup.

In some cases either all or a large portion of steam-generating equipment may have served its useful life, and the turbine-generators, though old, may still be good for a number of years' service. If the system is having a healthy growth, topping should prove attractive. If a portion of station capacity is under-boilered, topping may be applied to this portion, in which case gain in system prime capacity will be larger. Circulating water may be inadequate for further condensing capacity, in which case topping will put off temporarily construction of a new plant. It may also provide for load growth in a certain portion of a system which would otherwise have to come from some more distant point at the expense of additional transmission facilities.

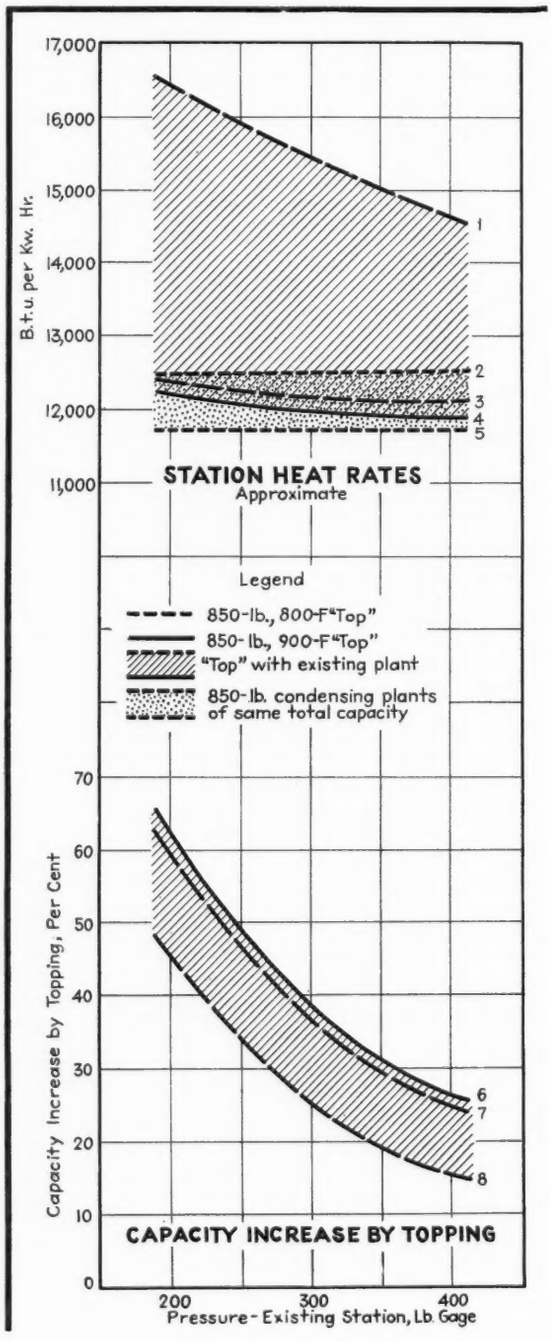
Topping involves increased use factors of existing low-pressure units. These will have been operated little or not at all during recent years. They represent an earlier state of the art both of design and of manufacture, and may have inherent weaknesses which would cause doubt of their operating reliability when subjected to the more severe conditions of high use-factor service. It is well to examine thoroughly each unit that it is proposed to top, and if there is any doubt as to the adequacy of any of its parts, to make such repairs and substitutions as may be required. In some cases it may be found that operating temperatures of old turbines may be increased at moderate expense by reconstruction of high-temperature portions with modern materials, thereby effecting an increase in combined efficiency. Cost of such rehabilitation varies widely, and in some instances amounts to as much as 50% of that of a new unit. This additional expense should be considered in any studies that are made whether or not any or all of the charge is made to capital account or to the maintenance column of the ledger.

Physical conditions surrounding topped installations differ materially one from another. There may not be space available in the existing building for the new turbine generator and an extension to the structure will be required or else radical interior rearrangement. Modern heat-absorbing equipment is materially different from the boilers of even ten years ago. It is frequently necessary to demolish the interior structure, leaving only exterior walls standing. Frequently headroom is insufficient, in the old boiler plant, and the roof must be raised. Redistribution and greater concentration of loads due to modern heat-absorbing equipment may require costly foundation changes or else some compromise with the most desirable number of such units to install. If old boilers are retained, a building addition will be required. The above applies equally, however, to a topping and to a condensing installation.

It can be seen, therefore, that no specific conclusions can be drawn that will apply to every case, nor is it possible to give more than a general idea as to construction costs. Topping will ordinarily cost more, per kw. of capacity added, than a condensing unit of the same capacity. The latter, however, provides more efficient generation only to the extent of the added capacity, while topping provides higher generating efficiency for the combined capacity of the topping and topped equipment, and topping will ordinarily cost materially less than a new plant having a capacity equal to combined capacity of old and new units affected.

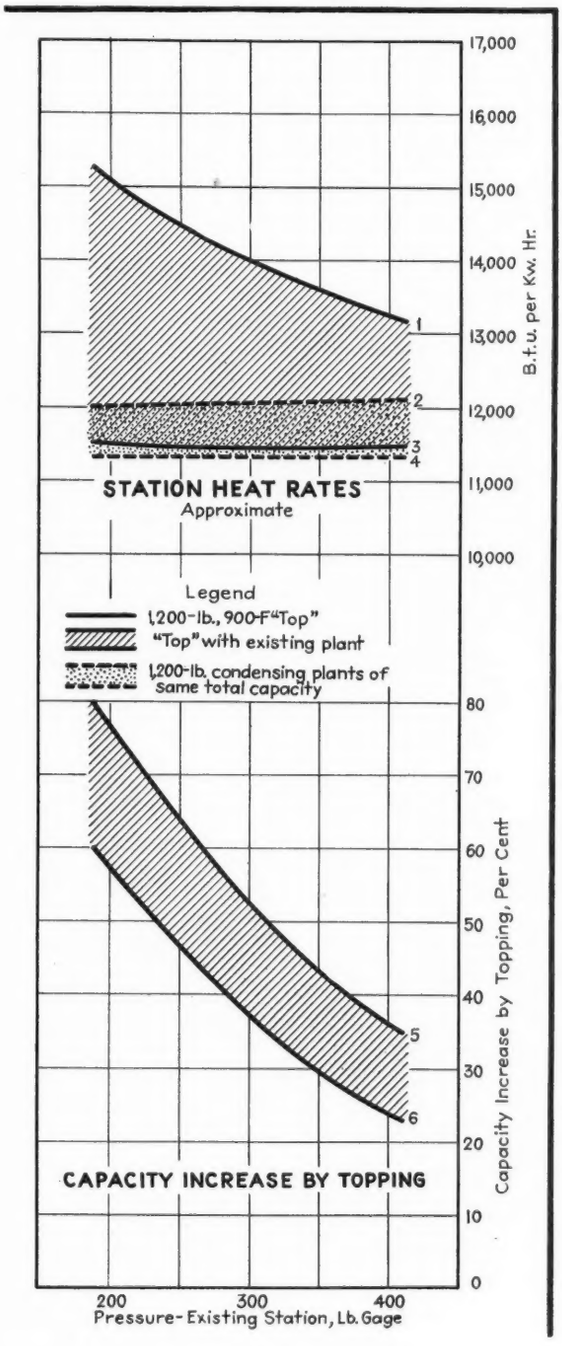
The problem may be simplified slightly by comparing costs per net kilowatt actually added by topping with the cost of a condensing installa-

Fig. 1—850-lb. top central stations: approximate range of station heat rate and capacity increase for existing station pressures at full-load operation



tion of equal capacity. On this basis, however, comparable heat rate for the added capacity will ordinarily be less than half the heat rate for the best obtainable condensing equipment. Assuming that topping turbines deliver steam to older units at the same pressure and temperature previously supplied by low-pressure boilers, and that these units therefore operate at the same heat rate as before, and also assuming that old low-pressure units would operate at the same capacity factor whether operating in parallel with a new condensing plant or in series with topping equipment, the net heat consumed by the superposed turbines alone should be materially less than 5,000 B.t.u. per kw.-hr. This figure should not be exceeded even after charging to the topping units all additional auxiliary power required over and above that needed by original boilers and turbines.

Fig. 2—1,200-lb. top central stations: approximate range of station heat rate and capacity increase for existing station pressures at full-load operation



Individual Solution

If, as is usually the case, new high-pressure boilers are more efficient than older low-pressure equipment, and this additional fuel saving is credited to topping, then net heat consumption chargeable to the additional power generated by the new capacity may be as low as 4,000 B.t.u. per kw.-hr. Obviously, in the present state of the art, no condensing installation can approach this efficiency. Therefore no conclusions can be drawn from a comparison of costs per kilowatt of added capacity for the two types of installation, and the problem is one for individual solution after a careful analysis of the situation in which a determination of capacity factors plays as important a part as first costs and fuel consumptions.

There is naturally an economic limit to the amount of topping capacity that may be added to a system, and this depends upon the load curve, the ratio of minimum to maximum load, the number of plants on the system, and their types. One particular instance that I have observed is illustrative. In this system there are two main steam plants in separated districts, and three hydro plants all connected by transmission lines. At times the amount of hydro power greatly reduces the amount of steam generation. Due to the necessity of having running steam standby in the two districts, it is necessary to run both steam plants continuously. This means that both plants are frequently operated at extremely low loads, and the economical topping capacity is less than it would otherwise have been. It was decided, therefore, to split the complete topping program for the plant into two operations of equal capacity, and to defer the second installation until growth of steam-generated load permitted higher load-factor operation.

The process of topping is essentially one of cross-compounding. If it is done on the unit system, that is the tying together of the topping and the topped units, it may be economical to operate them with a variable cross-over pressure, letting each unit take its proportion of the load. It may also be advisable to rearrange the blading of the topped turbine to permit it to operate at lower pressure and still give the full rated generator capacity. This increases pressure range of the topping turbine and consequently its capacity.

The usual arrangement in existing and contemplated topping installations is to have the topping unit operate at constant back pressure and exhaust into the existing low-pressure header from which one or more of the topped turbines take their steam. Load on the topping unit, therefore, varies with demand for low-pressure steam. In connection with this arrangement, there is installed a system of reducing valves and desuperheaters, usually operating automatically, which insures a continuing supply of steam to the low-pressure units, should the topping unit trip out.

Some systems supply power at both 60 and 25 cycles, the latter having no load growth. Topping at 60 cycles provides increased capacity where needed and continues the use of 25-cycle units until decrease of load or obsolescence forces their retirement. Increase in 60-cycle load can then be taken care of by the substitution of modern low-pressure units of this frequency. Except possibly in the larger systems, the initial topping installation realizes the greater proportion of gain in economy that can be gained, making the wisdom of an immediate repetition decidedly debatable. This is evidenced by the fact that in 1936 the majority of capacity additions, expressed both in number of units and in total kw., were "tops", while this year it is the reverse.

It is impossible in the scope of this article to deal at length with every conceivable condition affecting the decision "To top or not to top." I have attempted to hit only some of the high spots. What to do in any particular case can be determined only after a clear conception of the situation and a careful analysis.

What is a Dial Thermometer?

Thermometers have come to occupy an important position in power plants and industrial processes. In this and other articles the construction, characteristics and behavior of the various types under different conditions will be presented

By E. H. Hammond

Chief Engineer, Instrument Division, Consolidated Ashcroft Hancock Co., Inc.

DIAL THERMOMETERS are used wherever temperatures are to be noted quickly, accurately, and easily, or whenever temperature readings must be taken at a point distant from the thermal bulb.

The name "dial thermometer," used in this and following articles, is taken to mean a distant-reading type in which a hollow metal bulb is connected by capillary tubing to a bourdon spring. The bulb, capillary, and bourdon spring form a pressure-tight system filled with a thermometric fluid, Fig. 3. Pressure in this system increases or decreases as the fluid in the bulb is heated or cooled. This increase or decrease in pressure causes the bourdon spring to expand or contract. Linear motion of the bourdon tip is translated into rotary motion of the pointer shaft, usually by means of a sector and pinion movement, Fig. 3, and the temperature is indicated on an easily read dial, as pressure is in the well-known bourdon pressure gage.

This type of thermometer was first developed on the continent, probably about 1850. A search of old catalog files indicates that Schaeffer & Budenberg obtained a patent on one form of dial thermometer in 1879. However, since this company was established in 1850, it is more than likely that they were manufacturing dial thermometers prior to the date of this patent. Although this company introduced dial thermometers in the United States many years ago, it is only within recent years that they have earned an important position in thermometry. For a long time, industry seemed to feel that the only correct and accurate thermometer was the mercury-in-glass industrial type. This may have been true at one time, but now the standard commercial accuracy guarantee is 1% of the scale range for either type.

Present severe requirements of in-

Fig. 1—This panel with 18 dial thermometers gives an idea of this instrument's importance in refrigeration

1

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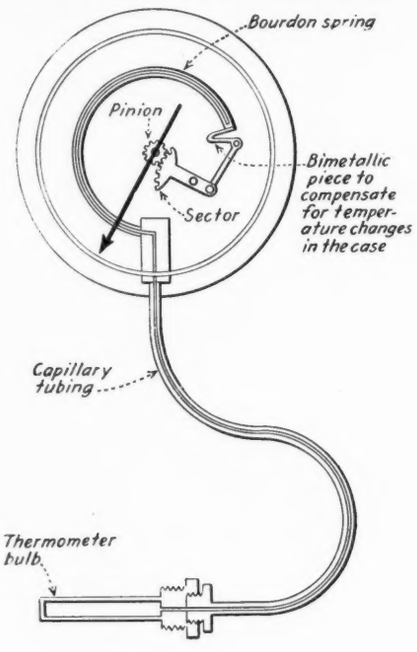
Fig. 2—Dial thermometer with bulb connected rigidly to back of case

Fig. 3—Diagram of thermometer bulb and indicating system for a simple dial thermometer



dustrial thermometry, such as ease of reading, convenience of location, durability, long life and accuracy can be fully met with dial thermometers. For example, a central instrument board, Fig. 1, requires a distant-reading rather than a mercury-in-glass type.

As demands have become more exacting, there have been corresponding improvements in dial-thermometer design. Perhaps the greatest single improvement has been in the technique of manufacturing bourdon springs. This improvement is the direct result of remarkable advances in bourdon pressure-gage design.

Another great improvement in manufacturing procedure is the technique which now makes possible the drawing of capillary tubing of almost unbelievably fine and uniform bore, held within extremely close tolerances. This fine-bore capillary is essential in manufacturing certain types of thermometers.

Dial thermometers can be obtained for temperatures ranging all the way from minus 200 to plus 1,000 F. They can be supplied with the bulb rigidly and closely connected to the case, Fig. 2, or with as much as 200 ft. of capillary between bulb and case, Fig. 4. They can be supplied with dials ranging from the size of a pocket watch up to a foot or more in diameter. Cases may be of iron, brass, die-cast alloys, or phenol condensate.

The thermometer bulb and armored capillary, Fig. 4, can be supplied entirely of corrosion-resistant alloys, as also can the instrument movement. The bourdon spring can be phosphor bronze, chrome-alloy steel, or beryllium copper to meet different operating conditions. Cases may be bottom connected, Figs. 4 and 5, or back connected for flush mounting. Design and finish of cases may match pressure gages mounted on a common instrument board. Some types have electric contacts for sounding alarms, and still others have a built-in or integral pneumatic controller of high sensitivity and accuracy.

With this range of material and service specifications to choose from, it is possible to select a dial thermometer for almost any application. But, because of the scope of specifications, it is desirable to define various types of dial thermometers in terms of construction, application, and characteristics, so that it will be easy to select the instrument most suitable for any general or specific service. Dial thermometers are divided into four classifications, as determined by the actuating fluid:

Class I—Mercury actuated. The entire thermometer system is filled solid with mercury under pressure.

Class II—Vapor-pressure actuated. The system is partially filled with a volatile liquid and partly with its vapor under pressure.

Class III—Gas actuated. The entire system is filled with an inert gas under pressure.

Class IV—Liquid actuated. The entire system is filled solid with a liquid under pressure.

Class I and Class IV sometimes are jointly classified as liquid expansion types; however, there is sufficient difference in construction and performance to justify classifying and describing them separately. Because of its importance in the dial-thermometer family, the mercury-actuated type will be first described in a subsequent article followed by the other three types in future articles.

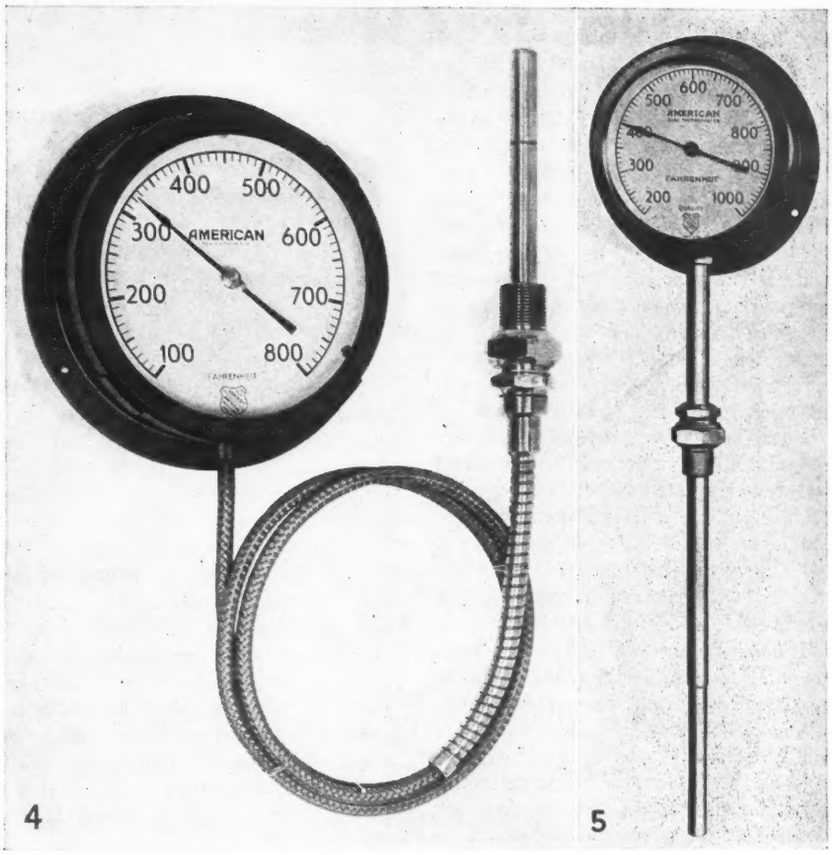
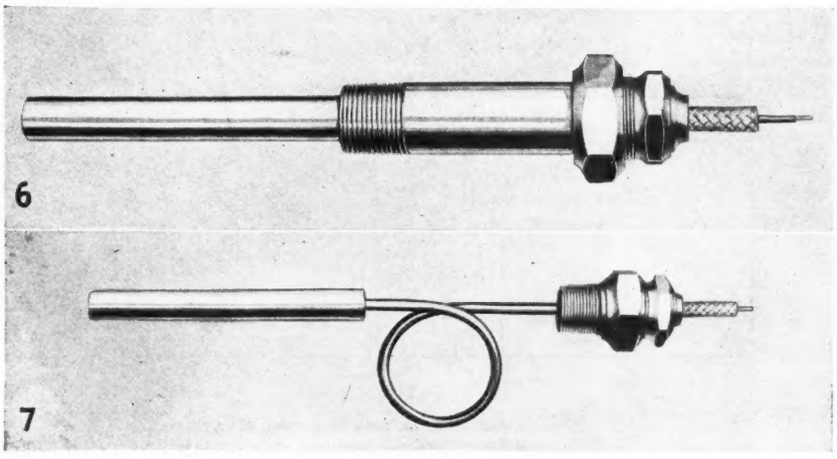


Fig. 4—Dial thermometers may have as much as 200 ft. of capillary between bulb and case

Fig. 5—Design arranged for vertical mounting, with the thermometer element connected rigidly to bottom of the case

Fig. 6—Union-connection, extension-neck bulb for pressure-tight connection through lagging or insulation

Fig. 7—Union-connection bulb with extension for bending after insertion to clear paddles or coils



Feedwater Filters

There are five classifications of boiler feedwaters. What type of filter material will you use—calcite, magnetite, anthracite, quartz or silica? Here is the answer

By H. D. Elfreth
Engineer
Cochrane Corp., Philadelphia, Pa.

HIGH-PRESSURE boilers require a very close control of feedwater quality, and engineers specializing in water conditioning have found one of the important factors to be character of the water filter material both in size and in chemical composition. Boiler feedwaters may be classified as: (1) raw water, (2) zeolite-softened water, (3) cold process-softened water, (4) hot process-softened water, and (5) condensate.

Raw water will usually require coagulation as well as filtration, and water which is to be softened by the zeolite process will ordinarily require the same treatment. Water softened by either the hot or cold lime-soda process will require filtration after leaving the softener, while condensate, if it contains any oil, will require both coagulation and filtration before being admitted to the feedwater cycle. Water of Classes 2 and 3 is normally softened "cold" (at a temperature below 125 F), and it is generally necessary only to select a filtering material that is properly sized, except where the alkalinity (pH value) is unusually high, in which case tendency of silica to dissolve in the water must be considered. Ordinarily, however, a crushed quartz or ordinary silica-sand filter bed will be satisfactory.

In the cases of hot softened water and condensate, it has been known for some years that filter beds containing silica, such as crushed quartz and ordinary sand and gravel, gradually dissolve. The dissolved silica subsequently reappears in the boiler as a silicate scale, usually in combination with calcium. A material that will not dissolve in hot soft or alkaline water is, therefore, required.

The experience of a plant operator who recently replaced calcite in his hot process softener with quartz, because of the latter's low cost, illustrates this point. When he opened the boilers a few months later, heating surfaces were found to be coated with a hard calcium-silicate scale. Analyses of the water entering and leaving the filter showed that the hot softened water had taken up silica from the bed, thus:

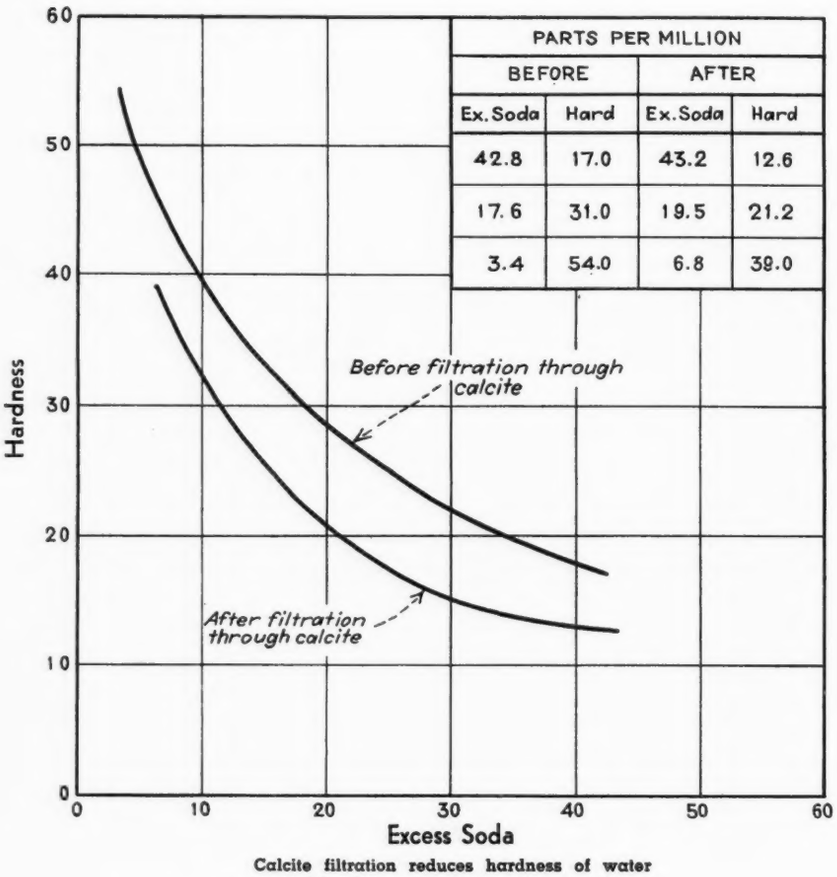
	Before Filter	After Filter
$CaCO_3$ (calcium carbonate)	0.70	0.64
$MgCO_3$ (magnesium carbonate)	0.17	0.17
SiO_2 (silica)	0.29	0.52
R_2O_3 (miscellaneous oxides)	0.06	0.06
Na_2CO_3 (sodium carbonate)	1.63	1.69
Na_2SO_4 (sodium sulfate)	4.96	4.96
NaCl (sodium chloride)	0.70	0.64
V. & O. (volatile & organic matter)	4.02	4.13
T. S. (total solids)	12.53	12.81
Suspended Matter	White	Trace

Increase in silica of 4 p.p.m. indicates the solvent action of the hot alkaline water. When the bed was changed back to calcite, formation of calcium-silicate scale in the boiler ceased.

For clarifying water from a hot process lime and soda softener, a calcite filter bed gives excellent results, not only because hot alkaline water does not dissolve the calcite, but also because the calcite bed encourages further crystallization of calcium carbonate from the water. This reduces hardness of the water below what could be obtained by chemical precipitation alone, as shown in the chart.

Samples were taken ahead of the filter of the softener and then filtered through an asbestos mat in the laboratory. Other samples were taken from the softener filter outlet. It will be seen that contact of softened water with the crystalline calcium carbonate (calcite) of the filter reduced the hardness by 25 to 35%. That calcium carbonate crystallizes out on the calcite may be seen by examining the calcite after considerable use. Formation of small crystals on the grains of calcite in time would bind the filter bed into a solid concrete-like mass, but this cementing action can be avoided by vigorous agitation with air or steam during backwashing periods.

However, a calcite filter bed is not suitable where water from a hot process softener receives, previous to filtration, a secondary phosphate treatment, or where raw water not requiring a lime and soda treatment receives only phosphate or phosphate and soda treatment. Since free phos-



Calcite filtration reduces hardness of water treated by hot process lime and soda softener

phate in unfiltered water would dissolve the calcite, calcium phosphate would form and remain in the bed. Also, hot condensate, because of its low pH value, will dissolve calcite and carry it from the filter in solution and subsequently, upon concentration in the boiler, again deposit it.

In one plant where the filtering material consisted of a layer of silica sand on top of a supporting bed of crushed Dolomite (mostly calcium carbonate), solvent effect of the condensate was such that hardness was increased from 4½ to 18 p.p.m., representing the solution of 13½ p.p.m. in the passage of condensate through the Dolomite rock. This pick up in hardness, naturally, resulted in considerable increase in the amount of phosphate required for boiler-water conditioning in order to prevent boiler scale and increased amount of sludge accumulation in the boilers.

It is necessary in such cases, therefore, to use a filtering material such as magnetite or anthracite, or both, which will not dissolve in either hot condensate or hot water containing free phosphate.

By reason of its heaviness, this mineral can be backwashed at a high rate without loss of fine material and without necessity of a high freeboard in the filter. It has been used in filters of lime and soda hot process softeners for the past 15 years, and some original installations are still in service with the initial charge of magnetite. It is particularly well suited for filtering phosphate-softened water and is sometimes used as a supporting bed for a filtering layer of fine anthracite. Magnetite's great density insures even distribution of wash water, while allowing the finer and lighter anthracite to rise from the bed and become thoroughly cleansed.

Anthracite

This is the lightest of all of the filtering materials referred to in this article and its applications are similar to those of magnetite. Because of its lightness, high wash rates must be avoided; the most satisfactory rate is between 8 and 10 gals. per sq.ft. of filter bed per min. The filter bed can consist entirely of anthracite or the anthracite filtering layer can rest upon a magnetite supporting bed. Anthracite for filtering purposes must be of a special high grade, containing the very minimum of impurities and not over 10% ash. The filtering layer, in particular, should be prepared under rigid specifications, as is the grade known commercially by the name "Anthrafilt."

Summary

Quartz or silica filter material is recommended for the clarification of cold raw water and cold process-softened water, and for filtering water supplied to a zeolite water softener.

Calcite or other non-silica filtering material is used for clarification of water treated with lime and soda in hot process or semi-hot process softeners.

Magnetite or anthracite, or a combination of the two, is used for clarification of hot condensate or water containing free phosphate.

In the table below, the data are given in tabular form, with some additional information.

	Wt. lb. cu. ft.	Back Wash Rate Gal/Sq. Ft.	Application
Magnetite.....	150	12–18	Lime & soda softener, Phosphate softener Oil-removal filters
Calcite.....	100	12–15	Lime & soda softening
Anthracite.....	60	10–12	Same as magnetite
Sand and gravel.	100	12–15	Cold water — generally for clarification of coagulant water.

Operating Tips

These suggestions are based on the author's personal experience in the operation of utility power plants. They deal not with theory but with simple everyday matters, whose neglect spells trouble and waste

By A. C. Andresen

Traveling Engineer, Interstate Power Co., Dubuque, Iowa

OPERATORS must maintain "operating efficiency," not merely thermal efficiency. The problem is to keep down production costs, while preserving equipment and avoiding shutdown and breakdown. Many of the tips that follow will be old stuff to the experienced operating man, but some will give him a new slant on his problems and all are worth while as reminders.

Boiler Room

Every plant supervisor knows the principles of heat saving, but many neglect them in practice. Take scale, for example. Every power man knows that scale, slag and soot hinder heat flow from fire to water, yet it's a fact that dirty tubes are the greatest cause of low efficiency in the average boiler plant today. The deposits form gradually and the operator-victim may be unaware of the bad condition until it becomes critical.

It's just as easy to overlook the many evils of uneven fuel beds: blowholes, clinkers, unconsumed carbon, stratification, low CO_2, secondary combustion. Most costly of all is the excess air that results from uneven fuel beds and infiltration through settings. To these outstanding losses, many plants add inexcusable waste of water and steam through leaky soot blowers, water-column valves, blowoff valves and

simmering safety valves on boilers.

Once the plant is built, the boiler room offers the alert operator more chance to save money than does the turbine room, but the latter has its troubles—and opportunities. Fouled condensers and air leakage into turbine exhaust materially increase the steam rate. Lots of money can be saved by proper division of load among the most economical turbines, and by keeping exhausts air-tight and condensers clean. Of course, turbine blades must be kept clean.

Boiler Water

Evaporators practically solve the problem of boiler scale where impurities do not come from condenser leakage. Plants not equipped with evaporators may use either filters and softeners, or boiler compounds, but scale may form if softeners or internal treatment are not properly managed. Even with slight hardness in the water, scale may form in spots and result in burnt or blistered tubes if there is flame impingement. Really soft water will prevent such troubles.

Concentration of boiler water must be checked periodically and corrected by blowdown to prevent carryover and resulting deposit of solids all the way from superheater elements to turbine blades. Clogged turbine steam passages reduce capacity and efficiency. To cure this trouble, siphon kerosene or hot water through the blades while the unit is rolling over just fast enough to maintain partial vacuum.

Lives may be endangered by deposits that cause governor and throttle valves to stick. Even where no scale or dirt is being deposited, it is good operating practice to close the throttle valve partly every day to make sure the valve stem won't stick in dry packing. This can be done during a light-load period when it will not affect operation of the turbine.

Condensers

It is hard to find just where air leaks into the exhaust system of a turbine, but such leaks must be kept low. Many ejectors are equipped with instruments to indicate quantity of air expelled. In plants not so equipped, try closing valves of air lines to the condenser ejectors to see how long it takes for the vacuum to drop 1 in. Less than five minutes indicates serious leakage. Improvement may come from adjusting and properly maintaining low-pressure packing on the turbine and packing on the hot-well pump shaft, or by remaking the many joints of the turbine-exhaust connection or water shell.

Cleaning condensers is no fun, but vitally important. Cleaning methods must depend upon the kind of deposit, and may require any one of the following or a combination: drilling, scraping, baking, shooting with rubber or special-type plugs, sand blasting, sluicing with water jets or using a solution of acid or special compound. "Fortunate is the chief who has grit in the circulating water." There is something in this; a small quantity will keep tube surfaces polished, but the quantities carried by some of our swift-running streams will cut pump sleeves, wear rings and impellers, erode ferrules and tube ends, and partially fill water boxes, pipes and tunnels. A low dam with an undershot gate at the intake-tunnel entrance will eliminate coarser particles.

Chlorine fed intermittently into the cooling water is frequently used to de-slime condensers. In some cases this treatment has reduced cleaning required from once or twice a week to once a year.

A safety device improperly handled or maintained is worse than none at all. We think of boiler-safety valves and turbine-overspeed governors as the most important safety features of the plant. If they fail, damage to life and property can be terrific; they must be kept in perfect working order. But don't forget that a non-working turbine atmospheric-relief valve can do as much damage as a sticking overspeed trip.

Getting Rid of Slag

Now let's turn back to the boiler room. As slag builds up on boiler tubes, it retards heat flow into tubes and also gas flow past them. Slag forms only in the higher temperature zones of the boiler. Continued high-rating operation, uneven or spotty fuel beds, or uneven division of load between boilers will cause slag. Type of fuel and equipment has a definite bearing. Soot blowers and steam or air lances, properly used, will remove soot and slag in most cases. Sometimes a jet of water is used to remove slag on the lower rows of tubes if it is impractical to take boilers off the line to clean. For a more thorough job, use a steam or water spray or a combination of the two when the boiler is down. The fine mist soaks the deposit and causes it to scale off after repeated applications.

Excess Air

Excess air is a great dollar waster. Primary causes are infiltration and uneven distribution of coal and air. A drop in CO_2 between the first and last passes of the boiler is a sure indication of infiltration. If leakage is not excessive, low CO_2 must be caused by poor distribution of air and coal on the stoker or other fuel-burning equipment. The only cure is proper maintenance, plus observation and trial.

In the case of stokers, check operation of dampers, primary and secondary rams, dump grates, clinker grinders, tuyere openings, etc. If ash is not properly ejected at the lower end of the stoker, clinkers may form and choke the lower section of the retort, at the same time restricting air flow through the adjacent fuel bed. The fuel may avalanche when large clinkers are dislodged during the dumping period, wasting much carbon to the ashpit.

With pulverized coal, the operator must strike a balance between losses caused by excess air and those caused by carbon in fly ash. Carbon loss, in turn, must be balanced against the added power and maintenance required to pulverize more finely. In making these comparisons, be sure to obtain an average sample of fly ash, since loading of the gas varies appreciably from one point to another in a given cross-section of the breeching.

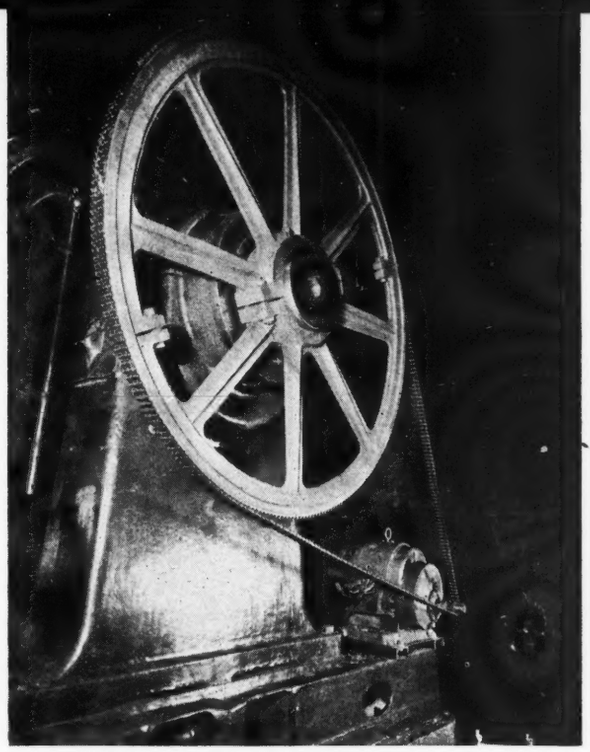
If excess air is reduced too much with certain coals, high furnace temperatures will greatly increase slagging troubles. Here again a practical balance must be maintained.

Valve tightness requires constant attention and maintenance. Leakage from blowoff valves has been reduced in some cases by using heat exchangers. These reclaim a large portion of blowdown loss, reduce the number of valve operations, and thereby prevent cutting.

The Whole Plant

Daily, weekly or monthly operating reports are of great value to show progress made. They should include: amount of fuel burned, its cost, water evaporated, steam and feedwater temperatures, boiler efficiency, total units manufactured and cost per unit.

Coordination is essential. Each specialized operator should have a general knowledge of requirements of the entire plant, as well as a detailed knowledge of his own duties. The repair department should know operating statistics, and be organized to carry out their work in a manner which will return equipment to service in the shortest possible time. Adequate supplies, spare parts and proper tools should be on hand when a job is started. Don't be like the proverbial plumber who always has to go back for another tool. Repair jobs should be workmanlike, finished and neat. A neat plant is usually a well-operated plant.



To true the rings and commutator the armature is rotated by a 3-hp. gearmotor and a roller-chain drive

An improved method of resurfacing in place commutators and rings of large d.c. machines overcomes objections to earlier practices

Resurfacing D. C.-Machine Rings and Commutators

By J. H. Mullaly
Service Engineer
Westinghouse Electric & Mfg. Co.

RESURFACING rings and commutators of large-size rotary converters presents something of a problem. Formerly, this work was done by setting up a tool post in a slide rest, and taking cuts at commutator speeds of 150 to 300 f.p.m. Because of excessive cutting speeds obtained, large machines could not be driven under their own power, and it was necessary to set up a large d.c. motor, and belt to a large pulley on an extension of the converter shaft. This equipment was heavy and cumbersome, required large space, and was not readily adjustable.

Later, grinding stones came into vogue and were an improvement over the older practice. These stones were set in holders in much the same manner as a turning tool, except that the converter was run by its own power at operating speed. If care was taken to make a rigid set-up and caution exercised in feeding the stone, it was possible to produce a satisfactory job. The large amount of stone and copper dust released into the air, where it could be sucked into other machines, even though an elaborate vacuum system was used to catch dirt, was a serious objection to this method.

Recently our service department in Boston developed a commutator turning rig which is light, compact, adaptable to various locations, has excellent speed control and reduced lateral tool travel. The armature of the machine is motor-driven through a multi-strand roller chain, as shown in the photo. The driven cast-iron sprocket has a 51-in diameter and 260 teeth. One of three steel motor sprockets, having 13, 23 or 30 teeth, respectively, may be used for rough speed adjustments; finer speed adjustment is obtained by motor field control. The motor, a d.c., 3-hp., 220-volt, 1,150-r.p.m. unit with a 4.5 to 1 gear reduction, in combination with the three sprockets, gives a converter-shaft speed range of 12.5 to 29.5 r.p.m., without field control. A small Micarta panel with necessary knife switches and three 2-ohm resistor units constitute the starting unit. On brackets, it is self-supporting and portable, and has long clip-lead connectors for convenience.

Adaptability

Adaptability of this rig is in a large part due to the motor's ability to "take it." Large machines have to be started by giving the converter armature a boost with a jack after the motor has been put on the line with all the starting resistance cut out. This is about 300% overload on the motor during the starting period. After a machine is up to speed, it requires approximately 2 hp. to roll it. At slow speed, rings do not deliver sufficient oil to converter bearings. To compensate for this, a 2-gal. oil can is set over each bearing, in secured brackets, and a stream of oil is allowed to run on each oil ring from two gas cocks.

The tool slide rest used for both commutators and rings has a lateral-lead screw with a pitch of four, and is hand-operated for roughing. A 30-to-1 reduction worm-gear mechanism then replaces the handle for finish cuts. On commutators, brush boxes are removed from an arm and the slide rest bolted directly to it, precaution being taken to make a rigid and secure mounting. The brush-arm holding-bolt insulation is removed and the arm is dropped against its bolts to avoid slipping.

With carboloy insert bits, commutators can be turned at speeds up to 620 f.p.m. on smaller machines. On large machines the most satisfactory speed seems to be about 350 f.p.m. for undercut commutators. The tool will stand higher speeds on flush commutators. A diamond point is used for roughing cuts, and a round nose of about $\frac{1}{8}$-in. radius for finishing cuts; otherwise both bits are flat on top and with but little rake, as the tool should point downward and be located a little below center of the job.

On rings, brush arms are removed from one side of a ring and the slide rest mounted on a pedestal supported by a rigid fabricated structural-steel frame adaptable to all machines of this class. Method of setting the tool is the same as for turning commutators. Rings can be turned about 100 f.p.m. faster than commutators.

Chatter, a common trouble experienced in this kind of work, is usually caused by the slide rest mounting not being rigid, dull bits, too much radius on the tool nose, worn slide rest, excessive cutting speed or too heavy a chip. By running a light finish chip at a slightly increased speed and reducing lateral feed to a minimum, a surface is obtained that does not require sandpapering.

Fluid Couplings Extend Diesel Applications

Three types of fluid couplings for diesel engines and electric motors provide a wide range of starting and operating characteristics

FLUID couplings are used both in Europe and on this side of the Atlantic for many applications in power and industrial plants, transportation, marine, excavating, mining, oil-well drilling and other fields to connect engines and motors to their loads. They have been built in sizes from 0.5- to 36,000-hp. capacity and for two general classes of service: variable-speed transmissions and automatic-clutch applications. The latter, as applied to diesel engines driving oil-drilling rigs, will be given particular attention here.

This article is based on a paper "Fluid Couplings and Their Applications to Oil-Field Equipment," presented by L. S. Dawson, Engineer, Oilwell Engineering Co., Ltd., Stockport, England, at the World Petroleum Congress, Paris, June of this year. Even though applications discussed here apply to oil-field equipment, they suggest interesting possibilities in other industries.

How Constructed

A fluid coupling (also called hydraulic coupling) has essentially a primary and a secondary element. The primary or input element may be considered a pump impeller and the secondary or output element a waterwheel runner. There is no mechanical connection between the two elements, as they are enclosed in a casing with a quantity of oil, Fig. 1. When the input impeller is driven it delivers oil to drive the output runner. Speed ratio between the two elements depends upon amount of oil in the coupling and the kind of load. With the coupling full of oil, at full load the slip may be as low as 2%. Torque of the output shaft is equal to that of the input shaft under all conditions of speed, slip and fluid volume in the coupling. Broadly, three types of fluid couplings are used industrially.

1. Scoop-tube type for obtaining adjustable speed from constant-speed motors by regulating quantity of oil in the coupling.

2. Traction type, containing a constant volume of oil and used as an automatic clutch, usually on variable-speed engines and motors.

3. Ring-valve traction type, also containing a constant volume of oil and used as an automatic clutch, but having an internal valve for regulating slip.

A traction-type coupling, Fig. 1, between a diesel engine and its load permits the engine to start without load and then gradually pick it up as the engine comes up to speed. It is impossible to stall the engine, because an overload merely pulls down engine revolutions and hence increases slip in the coupling. The output shaft may be stalled under full engine torque, while the engine continues to run at reduced speed. The reservoir chamber on the runner permits expansion of the heated oil and prevents excessive rise in pressure.

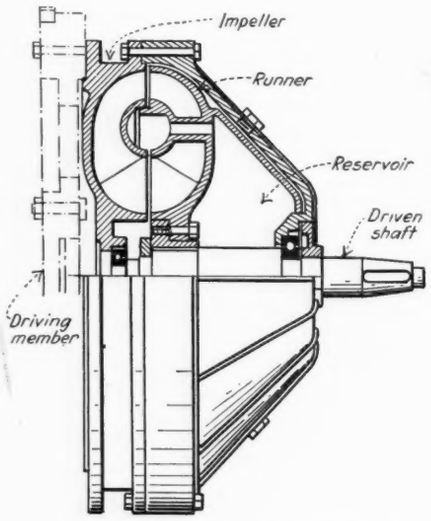


Fig. 1—Traction-type fluid coupling of conventional design

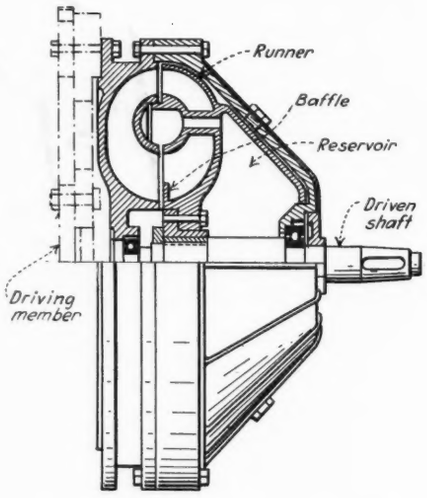


Fig. 2—Traction-type fluid coupling with runner baffle to limit stalling torque

Traction Coupling

The traction coupling, Fig. 2, differs from that in Fig. 1, in having a baffle in the runner to limit stalling torque. This type is applied to great advantage with variable-speed engines and motors, but is most desirable with squirrel-cage motors starting heavy loads. It slips at starting sufficiently to permit the engine to start the load easily and it has a low slip (high efficiency, 97 to 98%) under normal running conditions.

During starting, the baffle greatly impedes oil flow from the impeller to the runner, and consequently reduces the power transmitted. When the runner reaches practically full speed, the circulatory flow of oil within the impeller and runner is thrown outward by centrifugal force so that slip is as low at normal running speed and load as if there were no baffle. Conversely, when the coupling is overloaded, the baffle interferes with oil circulation when slip rises to about 5% and limits the torque that can be transmitted.

Fig. 3 shows the per cent slip at constant torque and the idling drag-torque characteristics of the traction-type coupling on a diesel engine, curves *A* with and *B* without a baffle. Curve *C* is the characterstic of the coupling without a reservoir, or one that is overfilled. When the engine is operating at 1,500 r.p.m. and loaded to development of its maximum torque, the coupling slips about 3%. Loading the engine beyond its maximum torque causes it to slow down and, in doing so, torque-transmitting capacity of the coupling decreases and its slip increases.

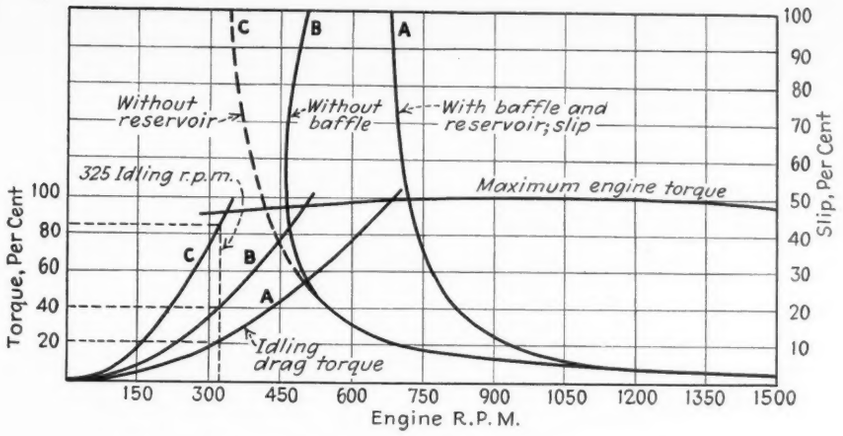


Fig. 3—Percent slip at constant-torque, and idling drag-torque characteristics of traction couplings, Figs. 1 and 2

Assuming a coupling with a baffle and reservoir, Fig. 2, its slip will follow along curve *A*, so that at 675 engine r.p.m. the load stalls against nearly 100% engine torque. If the engine is slowed down by throttling fuel supply, then the coupling-drag torque imposed on the engine will follow down along curve *A*, and at an idling speed of 325 r.p.m. develops a torque of only 22% of maximum with 100% slip in the coupling. The reason for the low load on the engine is that torque-transmitting capacity of the coupling varies as the square of the speed.

Without a baffle in the coupling, Fig. 1, its slip will be along curve *B* as the engine slows down and the load will stall at 500 r.p.m. At an idling speed of 325 r.p.m., the coupling drag-torque load on the engine will be higher, namely 40% of maximum torque for 100% slip in the coupling, curve *B*. Without reservoir or baffle in the coupling, curves *C* and *C*, the idling drag-torque at 325 r.p.m. is excessive for most drives, being 85% of maximum. From these curves it is evident that the coupling may be given almost any desired characteristic to suit the application requirements.

Ring-Valve Coupling

In the ring-valve coupling, Fig. 4, a movable internal annular baffle, termed a ring valve, reduces residual or drag torque to a low value when the coupling output shaft is stalled, as indicated in Fig. 5. When the engine is idling at 325 r.p.m., with the ring valve shut, drag torque is only about 7.5% compared to 40% when the ring valve is open. When the ring valve is open, the coupling will develop maximum engine torque at about 500 r.p.m., a torque value not obtained with the ring valve shut until a speed of 1,275 r.p.m. is attained. The latter permits using energy stored in the flywheel for starting stalled on high static-friction loads.

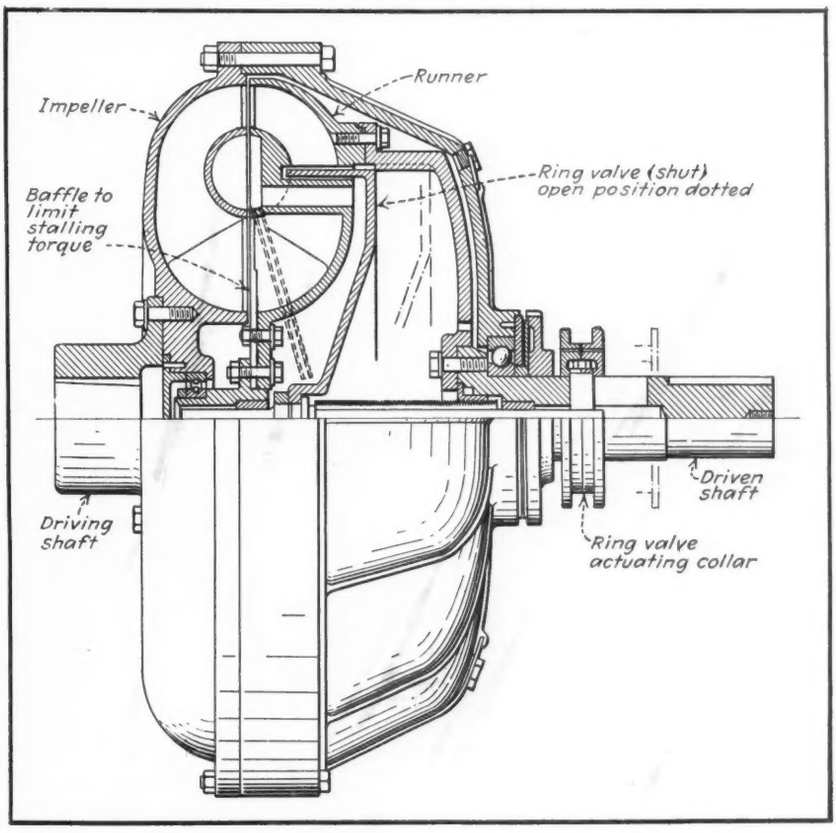
For example, in starting a high static-friction load, the engine is first brought up to a speed of 1,275 r.p.m., with the ring valve closed, at which point drag torque of the clutch equals maximum engine torque. Then by opening the ring valve, the coupling develops a torque that permits using flywheel energy of the rotating parts while the engine slows down to 500 r.p.m. Torque developed during this period may reach several times normal maximum value without shock to engine or transmission. Inertia of the engine flywheel and other parts will limit the time in which this torque can be developed, but for starting a heavy static-friction load, maximum torque is required momentarily only. Maximum slow down of the engine is to 500 r.p.m., at which speed the coupling drag torque is equivalent to maximum engine torque.

For simplicity, a plain traction coupling, Figs. 1 or 2, is preferred, as for slush-pump drives. When idling speed of the engine is relatively high, drag torque of the coupling is also high, as shown in Fig. 3. Then it is necessary to use a ring-valve coupling for such drives, as for example, drawworks needing a wide range of torque-control.

Initiative has been taken by certain European engineers, oil-well equipment manufacturers and oil companies in the installation of fluid couplings on oil-well-drilling rigs. These installations have been almost exclusive on diesel-driven equipment. Fluid couplings act as a flexible connection between prime mover and drilling rig to dampen any shock loads which the rig may impose on the engine and torsional vibration that the engine may transmit to the driven mechanism. This is an important consideration in designing modern drilling rigs.

Fig. 6 shows the results of tests made on a 6-cylinder, 550-hp., 450-

Fig. 4—Traction-type fluid coupling with ring valve for reducing drag torque when coupling output shaft is stalled



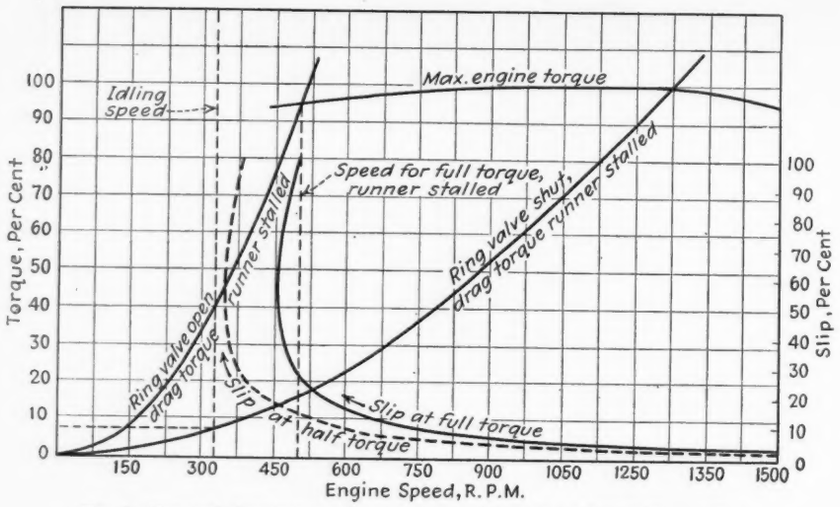


Fig. 5—Slip and drag-torque characteristics of the ring-valve fluid coupling

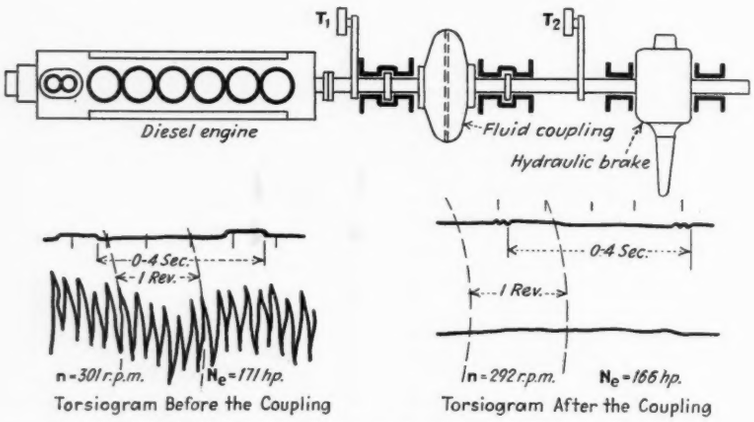


Fig. 6—Torsiograms show that the fluid coupling dampens out torsional vibration from engine to load and vice versa

r.p.m. diesel engine, connected through a fluid coupling to a hydraulic brake for applying load. The engine was operated at 301 r.p.m. and a load of 171 hp. The torsiogram on the left shows the torsional vibration in the shaft between engine and coupling. The torsiogram on the right shows that torsional vibrations in the output shaft have been completely absorbed in the coupling.

Effectiveness of this damping is shown in the case of a diesel-engine excavator having a fluid coupling operating with 17 others without these couplings. Rope life of the diesel unit with fluid coupling is in excess of 600 working hours compared to 250 hr. average for the others. A similar experience may be mentioned where crank-shaft failures on a diesel-driven portable air compressor resulted from fatigue cracks in the flange fillet, due to torsional oscillations between engine and compressor. Fluid couplings were installed on these units to facilitate cold starting, but they also eliminated fatigue cracks or crankshaft failure. In addition, the engines can now operate 3,000 hr. between overhauls as compared to 1,200 to 1,500 hr. for direct-coupled operation.

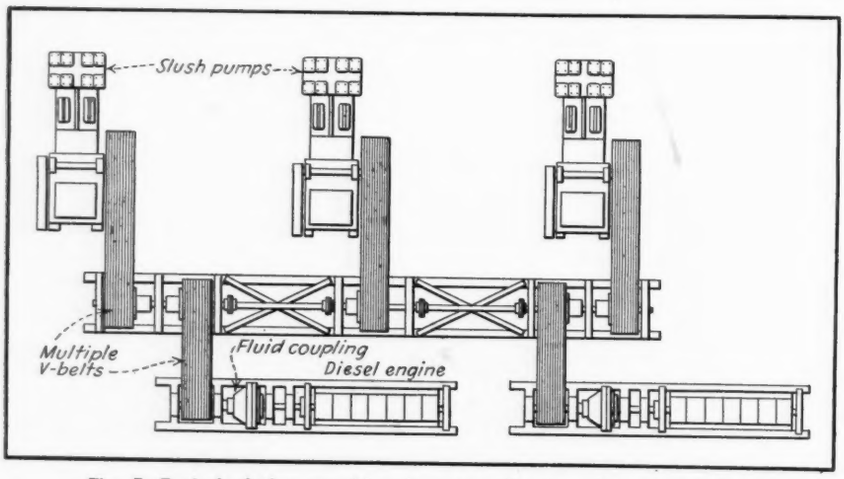


Fig. 7—Typical slush-pump drive from two diesel engines connected to line shaft through fluid couplings and multiple V-belts

Slush-Pump Drive

Fig. 7 shows a typical slush-pump drive powered by two 7-cyl. diesel engines, each driving through a traction fluid coupling. Each engine operates over a speed range of 180 to 600 r.p.m., has a normal rating of 294 hp., and is connected to a line shaft by a multiple V-belt. Three more multiple V-belts connect slush pumps to the line shaft. Each of the 5 pulleys on the line shaft is provided with a friction clutch so that either or both engines or any combination of pumps may be used. Normally, two pumps are operated with the third held as a spare.

The paper also includes a comprehensive study of diesel-engines and electric-motor applications to oil-well drilling equipment through fluid couplings, but space does not permit including it in this article.

The author gratefully acknowledges assistance given by the Hydraulic Coupling & Engineering Co., Islesworth, England, in the preparation of his paper, which will be made available in this country by the Hydraulic Coupling Division, Detroit, Mich.

Goggles

According to the hazard against which they guard, goggles may be divided into five classes: impact, dust, splash, fumes and gas, and glare and injurious light rays. Goggles for protection against impact should have clear glass lenses that will hold together when shattered and a frame that will withstand hard usage. Dust goggles should enclose the eyes completely.

To exclude liquid splashes, it is necessary to have a tightly fitting goggle with an eye cup of material impervious to chemicals and which makes a tight fitting joint between lens and retaining ring. Goggles for protection against fumes are similar to those for splash, except that there should be no ventilation openings. Glare-protecting goggles should have colored lenses, and in some cases special filter lenses to absorb injurious rays.

From National Safety Council's *Safety Practices Pamphlet No. 14.*

Piping Dips Cost Money

Rearrangement of vacuum-return piping eliminated pockets and ended complaints. Dirt pocket and lift fitting improvised from old parts made the vacuum pump work better

By Julius Brodsky

HEATING and power requirements of a group of public buildings were supplied from a central plant, through piping tunnels. New building required additions and alterations to the piping system as well as a new tunnel to accommodate the additional piping. Maximum demand of the heating system was approximately 30,000 lb. of steam per hr., and an 8-in. return line was used to convey condensate back to the plant, where it was handled by either of two 10x16x18-in. vacuum pumps.

Two Pockets

The 8-in. return line finally went in substantially as shown in Fig. 2; the section of piping through the engine room basement being laid on the floor, the line then dropped to the boiler-room basement so it would not interfere with the boilers, then rising to the vacuum pumps. This arrangement made two distinct pockets.

Hand-Controlled Pump

It was impossible to use a governor on the vacuum pump, so it was hand controlled. At all times it was necessary to have a stream of cold water entering the spray chamber in order to hold vacuum at 10 in. (at the pump), and it was not unusual during the heating season to receive complaints that some of the more distant offices were not receiving the required amount of heat.

During the off season, piping was somewhat modified by constructing a trench in the engine-room basement and dropping the section of piping in it, thus forming a continuously graded line to the riser at the pump, Fig. 2, where a lift fitting and dirt pocket were improvised from old fittings, Fig. 1.

A dirt pocket was needed as the heating system was very old and so much dirt and scale came back to the pumps that at the end of the season when the system was drained, the 4-in. drain valve was invariably found plugged. In operation, the 8-in. gate valve was closed and the 4-in. drain and ¾-in. vent opened up and the dirt disposed of. The vent and drain were then closed and the 8-in. valve opened. This was repeated every week or so, and the major portion of the dirt and scale thus prevented from getting back into the pumps. Although a lift of 5 ft. is generally considered the maximum desirable, in this case the height was 6 ft. 9 in. and worked satisfactorily.

6-in. Vacuum Increase

During the heating season succeeding this change, at no time was it necessary to use cold water in the spray chamber of the pump, and it was possible to maintain a 10-in. vacuum in the return line, whereas formerly the vacuum had been measured at the pump, thus indicating an increase in vacuum of at least 6 in. No further complaints have been received about heating, even in the most severe weather.

Fig. 1.—Vacuum-pump piping was also rearranged

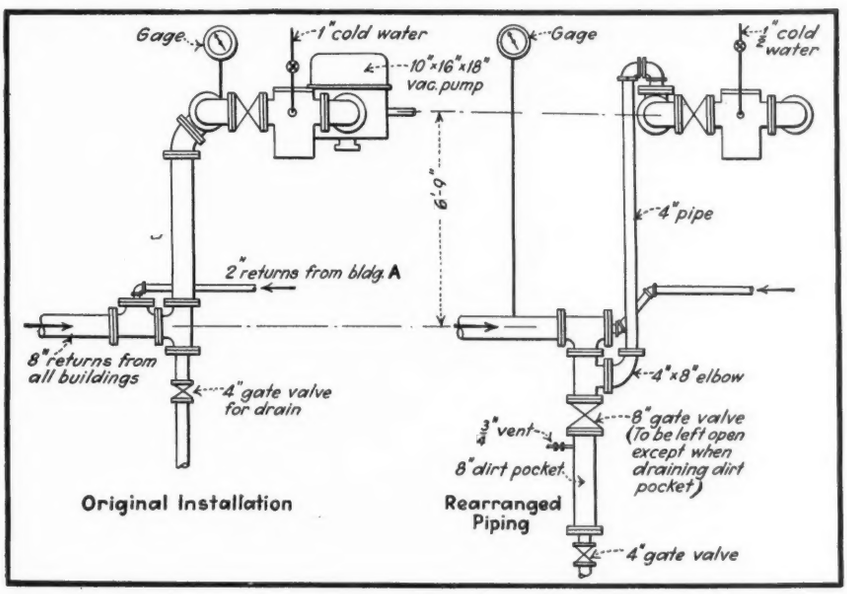
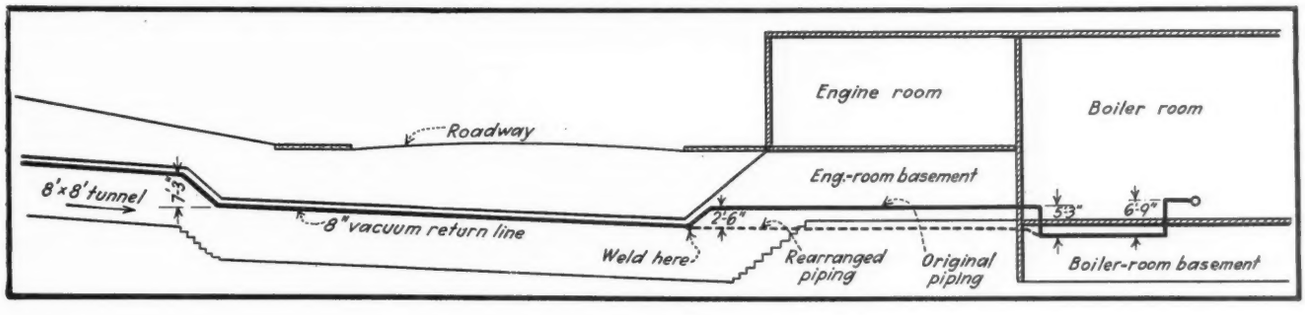


Fig. 2.—Rearranging piping, as shown in the dotted line, removed two pockets and improved efficiency



Repairing Cracks at Riveted Seams

Cracks at riveted boiler seams are dangerous and are frequently self-evident from leakage. They may be detected and properly repaired by methods here given

By A. G. Wiggins
Cleveland, O.

LEAKAGE through a riveted seam is an indication that some defect has developed. The defect may or may not be serious, but careful and competent investigation should determine its cause and extent.

Boiler plates and butt straps are rolled or formed to as near the same curvature as practicable and held tightly in place by rivets. Slight surface irregularities are sufficient to cause leakage under pressure. Calking of plate or butt-strap edges is necessary to assure a pressure-tight seal.

Failure of a calked edge is a common cause of leakage. In tracing the source of a leak, remember that it may have taken a very irregular course from its source. In Fig. 1, a typical example of leakage through a double-riveted butt and double-strap joint is shown. Leakage has followed the course of least resistance; not in terms of distance, but of surface irregularities. Recalking at the point of leakage on the outside, and for about a foot on either side of this point on the inside should make the seam pressure tight.

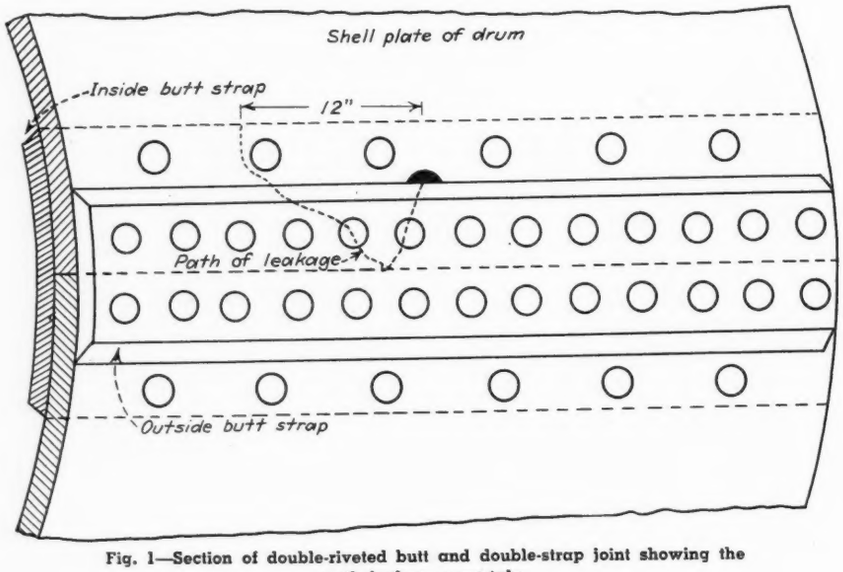


Fig. 1—Section of double-riveted butt and double-strap joint showing the path leakage may take

Calk Hot Boiler

It is good practice to do outside calking repairs when the boiler is filled with water at about 70 to 120 F, and at about 20% of allowable steam pressure. After repairs are completed, test the seam with water at the above temperature, and at a pressure of 1.5 times the allowable pressure on the boiler. Gag safety valves or remove them and blank connections during this test. Calking is dangerous with steam pressure on the boiler, and should never be attempted.

Fire cracks occur where a seam is exposed to direct heat of the fire as, for example, girth seams of a horizontal-tubular boiler and furnace-sheet seams of firebox boilers. Riveted seams of this type are usually of single or double-lap construction. Fire cracks usually extend from the calked edge to the rivet holes, or from the calked edge between the rivet holes, Fig. 2. A limited number are not dangerous unless they reappear in the solid plate beyond rivet holes or lap of the plate. Often it is unnecessary to make repairs unless leakage develops.

Fig. 2 at *B* and *C* shows respectively fire cracks prepared for welding and the completed repair. Rivets should be removed for at least 6 in. each side of the section to be repaired. Cracks are then prepared by cutting vees to permit proper fusion for the entire plate thickness. Veed sections are then welded by the electric-arc process using coated rods. If a crack appears beyond a rivet hole as at *A*, Fig 2, or between rivet holes, drill a $\frac{1}{4}$-in. hole and tap it with a pipe thread at the end of the crack. This prevents it from extending. A threaded steel plug is screwed into the hole and peened over. Rivet holes are then reamed out and new rivets driven into the reamed holes.

What Is Safe?

There does not appear to be a standard distance, agreed on by authorities, that a crack may extend past the lap, and still be considered safe after welding. An arbitrary value of 3 in. is given. Advice of an authorized boiler inspector should be secured in regard to proper repairs. Cutting out the defective plate and riveting in a patch is often necessary. Seal welding of the calked edge is sometimes advisable where leakage persists because of a surface imperfection of the lapped plates.

Cracking of the plate from rivet hole to rivet hole sometimes occurs. This is a dangerous condition and welding is neither safe nor allowed by boiler codes. Repairs with a riveted patch are permitted if they are recommended and approved by the boiler inspector.

An Uncommon Type

Another type of girth-seam crack that is rather uncommon occurs when a boiler "breaks its back." This type of crack extends circumferentially, sometimes for several feet. It is found at the lap of the plate, and it is usually on the inside course, and is caused by external bending stresses, usually produced by settling or by poor condition of the boiler setting or foundation. Do not operate the boiler in this condition; replacement of it is usually necessary.

As a rule, cracks in a longitudinal seam are more serious than in a girth

seam. Total pressure tending to burst a boiler along a longitudinal line is twice that along a circumferential line.

Lap Cracks

If the seam is lap riveted, there is always the danger of a lap crack, caused primarily by the plate not being rolled into a perfect circle for this type of seam. Offset at the lap produces concentrated bending stresses which may cause fatigue cracks. Serious explosions have resulted from this and modern boiler codes forbid using this type of construction for boiler drums with diameters over 36 in., or for over 100 lb. pressure. A longitudinal crack may be caused by embrittlement with certain boiler waters, and its danger is equally great. Carefully investigate source of leakage from these seams, removing sufficient brickwork to make external surfaces accessible.

Unless it can be positively ascertained that leakage is caused by defective calking, the plate should be slotted, Fig. 3. Slots may be $\frac{1}{16}$- to $\frac{1}{4}$-in. wide, depending upon tools available, and should extend from the outer plate calking edge, back between rivet holes to about halfway from the center line of the rivets, to the inner plate lap. Leakage will now show if either the inner or outer lap is cracked. It is usually advisable to cut out several rivets on each side of the point of leakage to examine rivet holes for cracks. A tubular-shaped microscope, designed on the periscope principle and known as a "Magnascope," has been deve'oped for this purpose. If a crack is found in the area of the longitudinal seam, the boiler should be removed from further service. Welding or other repairs should not be attempted.

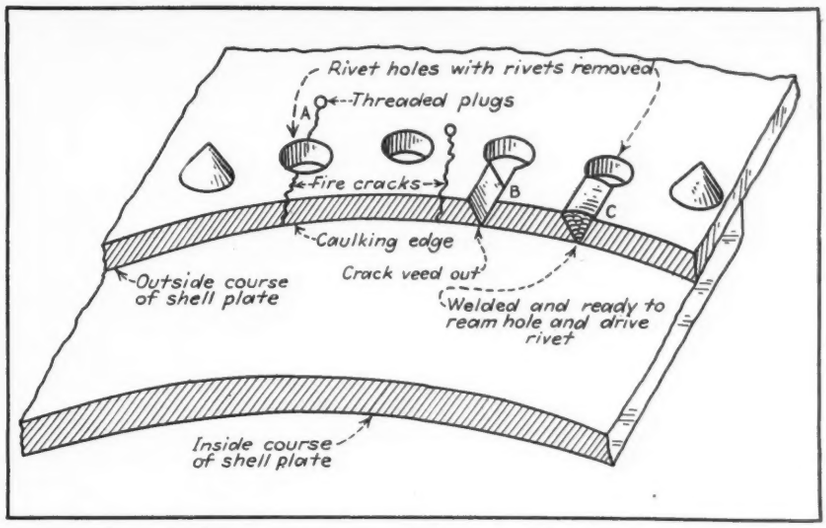


Fig. 2—Section of a girth seam showing where fire cracks may occur and how to repair them

Between Rivet Holes

Cracks sometimes found between rivet holes in butt-riveted seams may be caused by embrittlement or by defective construction. Such cracks are usually dangerous, and leakage may indicate their existence. When a crack is suspected, cut out several rivets in the doubtful area, and examine holes carefully as described for lap-riveted seams.

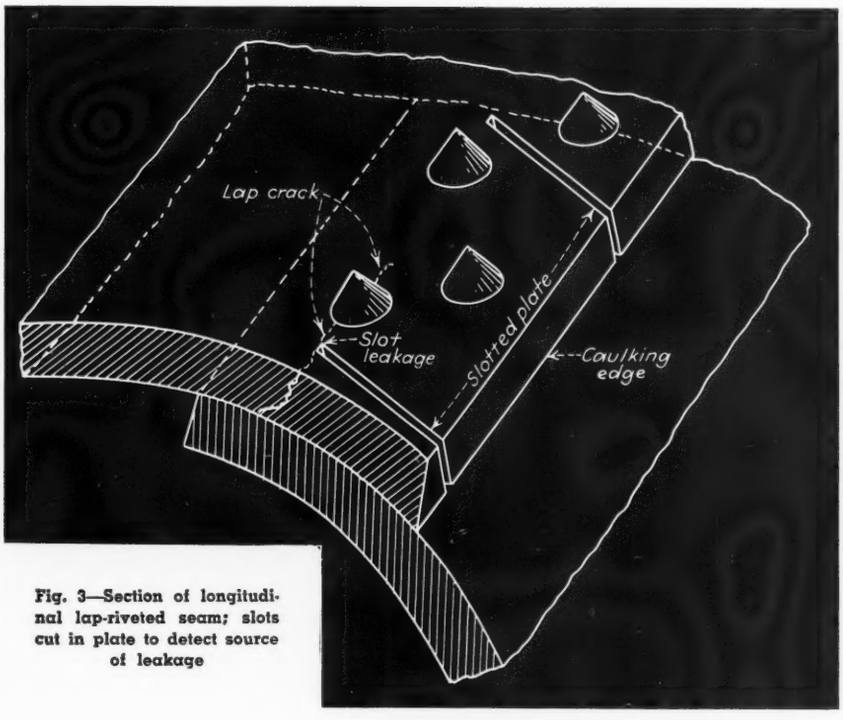


Fig. 3—Section of longitudinal lap-riveted seam; slots cut in plate to detect source of leakage

Red Lead in Hot Weather

It has been assumed often that to paint steel surfaces when they have become hot from exposure to the sun is bad practice. This conception is largely a result of two factors: that heat accelerates drying or oxidation of linseed oil and also causes linseed oil to expand and lose viscosity.

However, in considering this question, it must be remembered that red-lead and other paints can be successfully baked at temperatures ranging up to 200 F. Also, on hot summer days, there is often enough moisture in the air to counteract accelerated drying. There is, however, a definite problem caused by expansion and loss in viscosity due to heat with the result that paint becomes very thin. When paint in this condition is applied to a hot surface, it spreads so far that the resulting surface is very thin. In addition, the hot surface may cause trouble from running. This naturally would affect durability of the job.

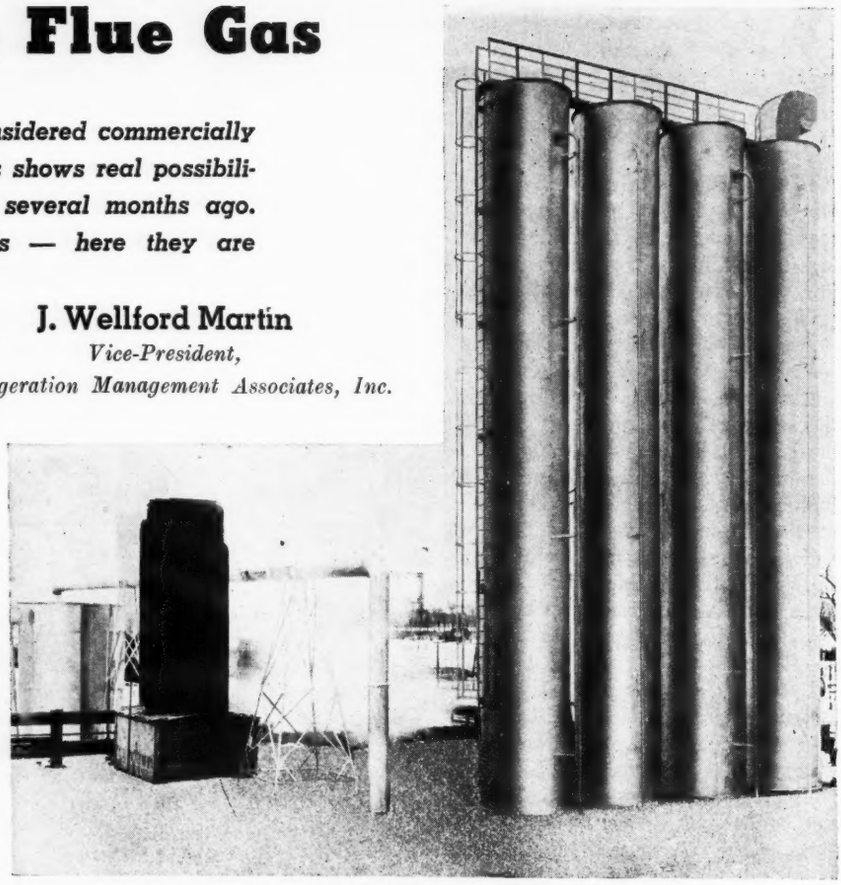
Paint While Hot

Aside from these two factors, however, which can be largely overcome by care in application and by allowing sufficient drying time, there is no reason why red-lead paint applied to a surface with a temperature of 115 F should not give good service. The superintendent of the old Louisville bridge of the Pennsylvania Railroad preferred to have all paint applied in the summer time and on days when the thermometer showed 90 F or more. As this bridge required painting only four times in 44 years, it shows that high temperatures had no ill effect on the paint's durability.—Abstracted from the *Dutch Boy Quarterly,* Vol. 15, No. 2.

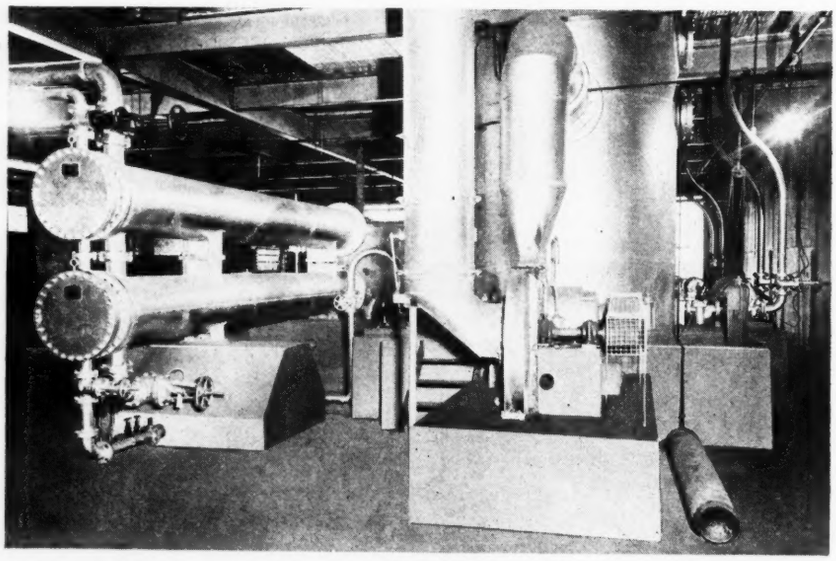
Dry Ice from Flue Gas

Long talked about, but considered commercially unpractical, a new process shows real possibilities. We mentioned this several months ago. Readers asked for details — here they are

By D. H. Killefer and **J. Wellford Martin**
Consulting Engineer
Vice-President, Refrigeration Management Associates, Inc.



CO_2 absorbers (right) with lye boiler (left) and water scrubbers (extreme left) at the plant of the International Carbo-Ice, Ltd., Toronto, Ont.



Interior view of the International Carbo-Ice plant showing flue-gas blower (center) to absorbers, ammonia-supply cylinder (right foreground), lye heat exchangers (left) and lye circulating pumps (right)

A NEW method for recovering carbon dioxide from flue gas of power plants in ample quantity and at favorable cost again draws attention to the importance of this type of refrigeration. The outstanding problems of the dry-ice industry have been to secure the CO_2 gas in the very high purity essential to the process and to convert this to solid near the point of use.

Sources of the gas are widely distributed, but the cost of recovering and concentrating it from the high dilutions of flue gas from power plants has heretofore been uneconomical. The industry consequently has preferred to utilize the high concentrations of gas available as a by-product from chemical operations and from fermentation, and as a matter of necessity has had to build coke burning plants where local production has been required. The cost of recovering CO_2 from any dilute form is high because the only satisfactory method for separating it from nitrogen consists in absorbing CO_2 in an alkaline solution and subsequently regenerating it in pure form by heating the absorbent. Several other methods have been proposed for accomplishing this result, but for one reason or another have been of limited application.

Thus, while the most common source of CO_2 is the ubiquitous smoke stack, the industry at present is using the following for its CO_2.

	Plant Capacity In Tons of Dry Ice Daily
Natural Springs and Wells	25
Fermentation	430
Lime Kiln and Chemical byproduct	360
Combustion of Coke	135
Combustion of Other Fuel	50

An analysis of the cost of producing dry ice in existing plants of more than twenty tons daily capacity can be broken down into the following approximate percentages:

Delivered Cost of Dry Ice	
Power and/or fuel	30%
Labor (inc. maintenance)	10%
Chemicals, supplies, etc.	8%
Depreciation and taxes	22%
Delivery expenses (inc. losses)	30%

From this analysis of cost it is apparent that power and delivery expenses are the major elements in deciding price. Thus, an ideal situation for a producing plant would be at a power-producing unit near a center of population. Such a location would permit the use of off-peak or incremental power in its operations, which could be secured at low rates. It would permit erection of a plant with a minimum of investment since much of the cost of an operating plant is that of the power producing units. It would further allow plants to produce within areas of relatively dense population, and thus would avoid the long period of transportation between the sources of by-product gas and consuming markets.

These considerations led inevitably to the conclusion that an alliance be-

tween dry-ice producing units and steam power plants is highly desirable for the future growth of the industry and stimulated the search for a process that would permit CO_2 to be economically recovered from flue gas.

Key to the Problem

The key to this problem was a suitable process to concentrate CO_2 from flue-gas mixtures containing as little as 8 to 13%. Many proposed methods have been considered and investigated in an effort to solve the problem of concentrating CO_2 from these dilute mixtures. Among these were the precipitation of CO_2 as solid or liquid by compression and refrigeration; absorption in alkaline liquids or solvents with or without pressure; absorption of CO_2 in solutions of organic amines; absorption in alkaline solutions containing various addition agents, and numerous combinations of these processes. None of these meets the essential requirements.

From these investigations grew the Macmar Process, which showed itself satisfactory for the purpose in original laboratory trials, in a pilot-plant installation operating on a scale of ½ ton per day, and finally in full-plant scale operation at 15 tons daily capacity.

The process is similar in many respects to the alkali process usually employed and the equipment used for it is practically the same. Flue gas (after suitable washing with water and dilute bicarbonate solution to remove dust, sulphur dioxide and soluble impurities) is passed through a series of three packed towers or absorbers. In the second tower of this series is pumped hot potassium-carbonate lye (130 F) and ammonia is added as required to give a substantial concentration in the gas mixture. Either anhydrous or aqua ammonia may be used. The lye from the base of this tower is cooled below 100 F and pumped into the top of the third or gas-exit tower. From there after being reheated, it is pumped to the top of the first, or gas-entrance tower. From the bottom of the first tower the lye carrying CO_2 in solution as bicarbonate is pumped into a lye boiler where CO_2 is released by heat. The lye, thus freed from a large part of its CO_2, is recycled over the towers as described above. In installations of small capacity a single tower suitably divided into sections may be used.

The essential part of this new process is the introduction of gaseous ammonia into the absorption towers down which potassium-carbonate lye is trickling. This gaseous ammonia readily reacts with the CO_2 in the flue gas even at low concentrations in the presence of moisture. So long as there are appreciable amounts of gaseous CO_2 and ammonia present in the moist atmosphere of the tower they will combine to form ammonium carbonate (or bicarbonate). The ammonium compound is a highly soluble solid and is immediately dissolved by the alkaline solution descending the tower. At temperatures around 130 F, ammonium carbonate is decomposed in the alkaline solution forming potassium bicarbonate and liberating ammonia to react with more CO_2. By thus performing the principal reaction of the absorption process in the gaseous phase, the resistance offered to the reaction by surface films separating gas and liquid is practically avoided. Since these film resistances tend to make reaction slow, the introduction of gaseous ammonia into the absorbers produces a reaction which is rapid and virtually complete, even with flue gas of low CO_2 content.

While the bulk of the ammonia in its cycle of reactions remains in the central tower, some is carried over into the third tower by entrainment in the flue gas. In this last tower, by regulating flow of flue gas, CO_2 content is kept above 2%, for in such an acid atmosphere ammonia reacts quite completely. In the down-flowing cold alkaline solution and further in the spray catcher on top of this exit tower, practically all ammonium compounds are dissolved and carried along with the solution. In practice loss is less than a pound of ammonia per ton of CO_2 produced.

Ammonia Recovery

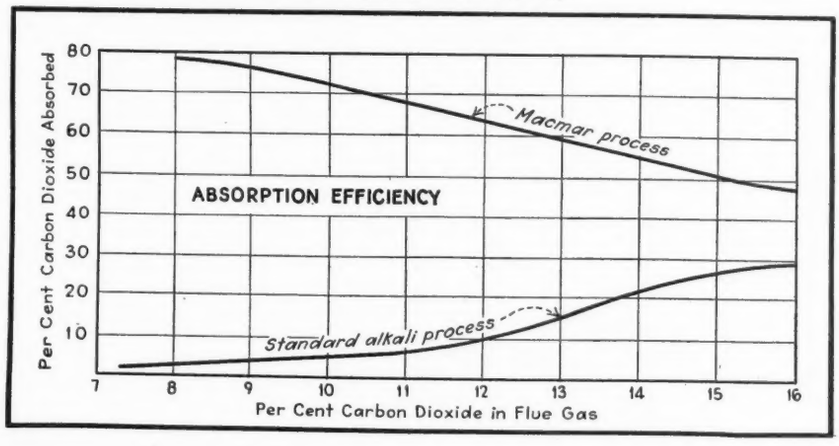
Some ammonia is carried over to the lye boiler in the absorbent solution in the form of carbonate and bicarbonate. This is recovered in the water condensed from the CO_2 gas evolved in the lye boiler and is pumped back to the absorption tower. All traces of ammonium carbonate are trapped out in moisture traps and dryers in the compression of the gas and no trace remains in the resultant liquid CO_2. Several years of sale of this product to the extremely critical bottling trade is an evidence of the complete removal of all traces of ammonium compounds.

Three types of absorption towers were considered. Bubble cap towers are advantageously used with gases which are slightly soluble in the liquid absorbent, but the power required to pump gas through them is relatively high. Spray towers generally possess relatively low absorption capacities under conditions met in CO_2 absorption and because of the difficulty encountered in preventing loss of lye by entrainment were considered uneconomical. Packed towers with wetted packing surfaces are considered the preferred type by the carbon-dioxide industry and possess substantial advantages both in low entrainment loss of liquid and in high efficiency at low back pressures.

Among the several types of packing available, choice was made of steel turnings which, if carefully selected and sieved free from small particles (¼-in. mesh), is highly efficient. This packing possesses advantages in use over stone or pottery rings which are slightly soluble in warm alkali, wooden board gratings which alkali attacks, and coke whose high absorptive capacity for solution keeps much of the absorbent out of action. For desorption a standard lye boiler was used.

Any of the usual methods of compression, refrigeration and pressing may be used after the gas has been purified. The accompanying curves show results of pilot-plant test runs of the Macmar Process in comparison with similar tests of the alkali process. These results have been confirmed in commercial scale manufacture.

Results of a pilot-plant test reveal advantages of ammonia as a supplementary absorbent at concentrations below 14% CO_2



Tops Under Light Loads

Additional load can be carried on a low-pressure turbine-generator by applying unused top-generator capacity to improve p.f. A chart does it

By J. M. Lyons and L. E. Newman

Turbine Div., General Electric Co., Lynn, Mass.

STATIONS having a single superposed turbine frequently experience a condition during light loads when it is desirable to develop maximum load from the superposed turbine and low-pressure turbine before placing more low-pressure turbines on the line. This condition usually results when only a single low-pressure unit is taking steam from a superposed turbine that is large enough to supply all the steam required by two or more low-pressure units. When so operating, the high-pressure turbine-generator is carrying only a fraction of its rating when the low-pressure turbine-generator is delivering full rating. Obviously, the more load these two sets can carry without exceeding generator rating, the more efficiently the station can be operated.

Improve Power Factor

Assuming fixed cross-over pressure, the only way additional load can be carried on the combination, without exceeding the rating of one generator, *is to make available the unused generator capacity of the superposed turbine unit to improve the power factor of the low-pressure turbine-generator.* This can be done by operating the superposed set at low power-factor and the low-pressure set at high power-factor, in this manner substantially increasing the total kilowatt output of both generators.

The accompanying curve has been derived to make it easy to determine the maximum output from such a combination, and use of the curve is explained by the example.

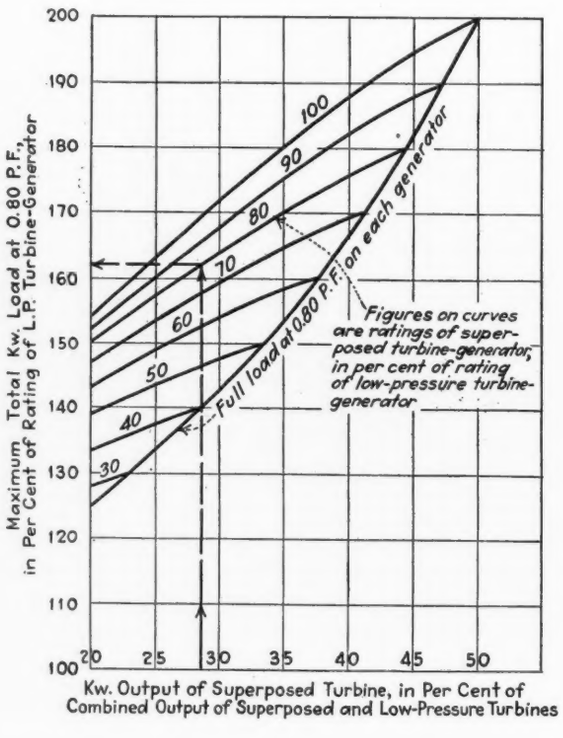
Example—Assume a station consisting of two 5,000-kw. low-pressure condensing turbines and one 4,000-kw. superposed high-pressure non-condensing turbine. Assume, also, that: (1) station load averages 0.80 p.f. lagging, (2) size of the non-condensing turbine is such that at full-load all generators are carrying their rated load at 0.8 p.f., (3) power generated by the superposed turbine is always 40% of the total power generated by the low-pressure turbines.* For light-load operation, one low-pressure turbine is taken off the line, and the remaining maximum capacity of the superposed turbine and single low-pressure set would normally by 7,000 kw. (There is one 5,000-kw. and one 4,000-kw. set on the line, but the high-pressure unit will develop only 40% of the capacity of the low-pressure unit which it supplies with steam. Therefore, when full-load of 5,000 kw. is reached on the low-pressure turbine, the high-pressure turbine is carrying only 2,000 kw.)

By increasing excitation of the superposed turbine-generator and operating the two generators at different power factors, a greater total load can be carried. On the curve, the output of the superposed turbine (2,000 kw.) is 28.6% of the combined output (7,000 kw.). Enter the curve at 28.6%, on the bottom scale and read the maximum output at the intersection of this line with the line representing the percentage (80) which the rating of the superposed set (4,000 kw.) bears to the rating of the low-pressure turbine-generator (5,000 kw.). Maximum output, from the curve, is 162% of the low-pressure generator's rating. This output is equal to 8,100 kw. (162% × 5,000), an increase of over 15% above the original 7,000 kw.

When the two generators are carrying this maximum total load the division of load between them will be:

	kw.	Reactive kva.	Total kva.	pf.
Superposed unit (0.286 x 8,100)	2,315	3,700	4,365	0.530
Low pressure unit (8,100-2,315)	5,785	2,375	6,250	0.925
Total load	8,100	6,075	10,125	0.80

It is interesting to note here that maximum output of the combination does not occur with full kva. at unity power-factor on the low-pressure turbine-generator. Power-factor of this generator must be such that maximum corrective kva. obtainable from the other generator gives the largest total kw. output from the two machines for the given ratio of turbine



Maximum outputs from two unequally loaded generators operating in parallel with total load at 0.80 p.f. lagging

*To assume that power generated by the superposed turbine will be a fixed percentage of the load carried by the low-pressure turbines is too great a simplification for actual studies. This percentage will vary with different conditions of loading, and, in a specific case, the guaranteed performance curve of each turbine should be used to determine the true per cent load carried by the superposed turbine under the actual operating conditions.

outputs. In general the low-pressure unit will operate at unity power-factor only when the superposed generator is larger than the low-pressure generator and is operating at a load small enough to give it enough unused capacity to supply all the wattless kva. that is required by the combined load.

There are two electrical limits which must not be exceeded when operating the generators with different power-factors. These are: (1) Nameplate field amperes of the superposed turbine-generator (low power-factor operation) (2) Nameplate armature amperes of the low-pressure turbine-generator (high power-factor operation).

With some combinations of high-pressure and low-pressure turbines operating in series, the total load carried can often be further increased by allowing cross-over pressure to float. This is done by blocking the low-pressure turbine valve gear wide open and speed governing the superposed turbine, with the result that the cross-over pressure is lowered. As the cross-over pressure is lowered energy is shifted from the low-pressure turbine to the superposed turbine, permitting the high-pressure unit to carry a greater proportion of the total load. For this case the curve of maximum output is equally useful, but care must be taken in determining correct percentage load carried by the superposed turbine. (Per cent load varies with cross-over pressure and with load.)

Maximum loads estimated from the curve are close approximations based on average generator characteristics. Minor differences between the characteristics of specific generators and those used for the curve should not affect the value of the data.

Rest in Pieces

Fireman Harry John Dhovel
Grinding an edge on his shovel
Leaned hard 'gainst the steel
And shattered the wheel—
Which punctured both shovel and Dhovel.

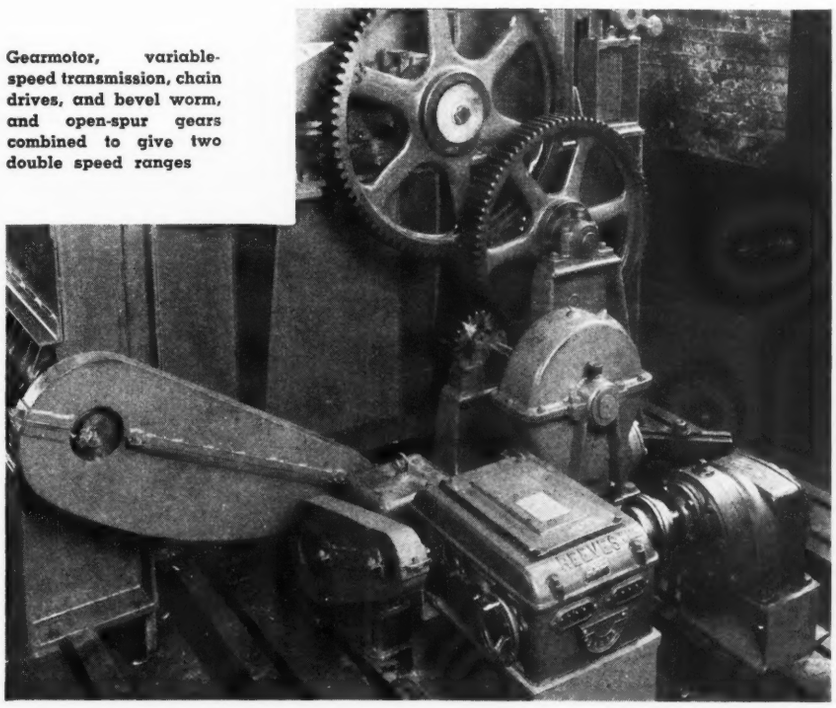
Oiler Bjornson went swimmin'
Our spray pond he looked very slim in.
Some dames happened by
Stole his duds on the sly—
He's still yellin' after those wimmin.

List the tale of Oiler McGuire
Who, lighting the boiler, caught his trousers afire.
He ran to the doctor, then fainted with fright;
The doctor just told him his end was in sight.

Goggles were a bother to Jim
They were "sissified stuff" to him
But chips that are high
Caught Jim in the eye—
Now glass replaces one glim.

Power-Transmission Coalition

SHOWN in the photograph is a good example of how modern mechanical power-transmission equipment may be combined to meet modern power-application requirements. With this combination and a constant-speed motor, two output shaft speeds are obtained, each of which bears a definite relation to the other while being adjusted over a range of 4 to 1.



Gearmotor, variable-speed transmission, chain drives, and bevel worm, and open-spur gears combined to give two double speed ranges

At the lower right-hand corner of the photo is the gearmotor, speed ratio of 2.86:1, which connects by a flexible coupling to the input shaft of a variable-speed transmission. The output shaft of the latter has a speed range of 1:1 to 4:1. The variable-speed unit connects by chain drive (2.73:1 ratio) to a totally enclosed bevel gear that provides a right-angle and a straight-through drive. The right-angle drive (speed reduction 1.5:1) connects to one shaft of the driven machine by a chain drive having a ratio of 3.6:1. The over-all speed ratio of this drive ranges from 42.1:1 to 168.4:1, depending on the setting of the variable-speed transmission.

The straight-through input shaft of the bevel gear connects by flexible coupling to a totally-enclosed 40:1 worm-gear unit, in which the worm-shaft runs in roller bearings. Finally, the worm-gear shaft connects to two successive spur-gear reductions, each having a ratio of 4.3:1, giving an ultimate speed-reduction range on the upper shaft from 5,780:1 to 23,120:1. The equipment, shown here assembled on the erecting floor of the Dominion Engineering Co., shops in Montreal, is compact for the elements involved, as it has an extreme over-all dimension of 7 ft. wide and 4.5 ft. long.

1850-Lb. "Top" at Sea*

High efficiency and dependable operation reported after extended sea tests of "Conte Rosso," recently modernized by topping old power plant with Loeffler boiler and high-pressure turbines

THE ITALIAN (Lloyd Triestino) S.S. "Conte Rosso" is an 18,500-gross-tonnage ship commissioned in 1922. Original power equipment included six double and two single Scotch-marine boilers generating steam at 200 lb. and 572 F. Medium and low-pressure turbines (1 of each geared to each of 2 propeller shafts) had a total capacity of 17,000 shaft hp.

In March, 1936, the vessel was given a general overhauling. Power was increased from 17,000 to 22,280 hp. by an 1,850 lb. "top." This increased the speed 1½ knots.

One of the single-ended, 16,000-lb. per hr. Scotch boilers was replaced by a Loeffler marine boiler, generating (normally) 44,000 lb. of steam per hr. at 1,850 lb. and 890 F. Maximum steaming rate is 55,000 lb. Except for the one low-pressure boiler removed, all of the original low-pressure power equipment of the ship was retained.

The new turbine installation consists of two high-pressure impulse machines manufactured by Escher-Wyss, Zurich, Switzerland. One is coupled by gearing to each propeller shaft. The two new turbines work in series, one receiving steam at 1,780 lb. and exhausting at 668/655 lb. to the other, which in turn exhausts at 213/200 lb. through a steam reheater to the low-pressure plant.

Preliminary trials included the discharge of the full output of the Loeffler boiler through safety valves for a period of 20 min., and the instantaneous cutoff of the supply of steam to the high-pressure turbine when the boiler was operating at full load. After that the ship sailed from Genoa to Shanghai and made similar subsequent trips.

Fig. 1 is a flow diagram of the complete power plant; the table gives performance data. The old plant consumed 0.935 lb. of oil per shaft hp.; the new 0.836 lb.

Fig. 2 is a vertical cross section of the Loeffler boiler. Side and back walls of furnace are cooled with closely spaced steam tubes forming the radiant superheater. The economizers and the steam tubes forming the convection heating surface are above the combustion chamber, providing the horizontal pass for the

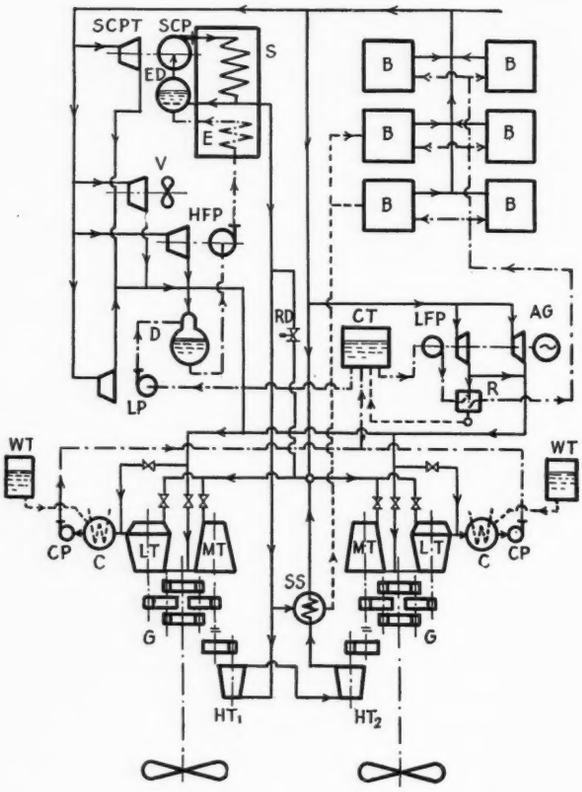
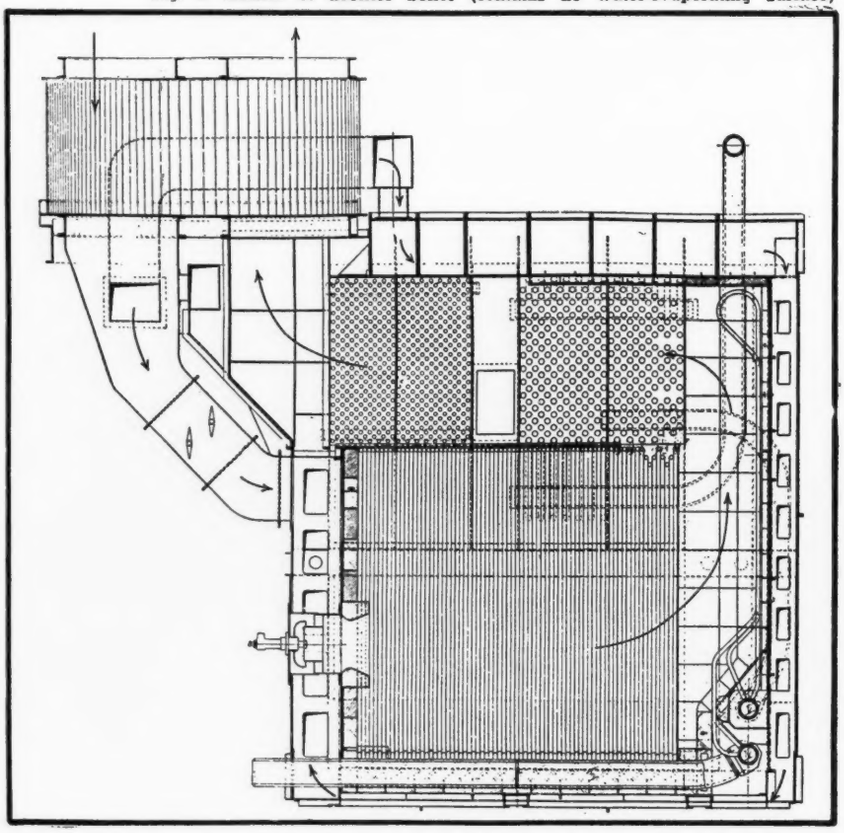


Fig. 1—Hookup of power equipment on S.S. "Conte Rosso"

S	Superheater
E	Economizer
ED	Evaporator drum
SCP	Steam circ. pump
SCPT	Steam circ. pump turbine
V	F.D. fan
HFP	H.P. feed pump
D	Deaerator
LP	Lift pump
B	Scotch - marine boiler
LFP	L.P. feed pump
R	Feed reheater
HT^1	First hp. turbine
HT^2	Second hp. turbine
MT	M.P. turbine
LT	L.P. turbine
G	Gear
SS	Steam to steam reheater
CP	Condensate pump
CT	Condensate tank
C	Condenser
WT	Water tank
AG	Auxiliary generator
RD	Reducing valve

Fig. 2—Section of Loeffler boiler (contains no water-evaporating surface)



* The information and illustrations here presented (except Fig. 4) are abstracted from a paper presented March 9 by F. McEwen of Mitchell Engineering Co., before the Institute of Marine Engineers, London.

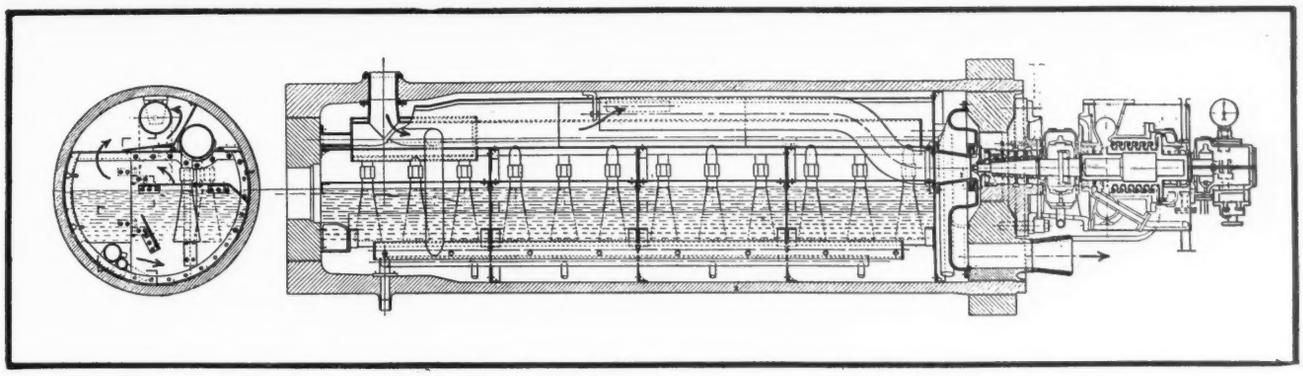


Fig. 3—All evaporation takes place in this vaporizer, through which highly superheated steam is circulated by the turbine-driven pump at right

PERFORMANCE DATA, OUTPUT 22,280 HP.

Loeffler Boiler Plant

Boiler output	44,000 lb. per hr.
Superheated steam pressure	1,850 lb. gage
Superheated steam temperature	890 F
FEED WATER	
Temperature feedwater, boiler inlet	250 F
Temperature feedwater, leaving econ.	464 F
Stack temperature	300 F
CO_2	12%
Efficiency Loeffler boiler	90%
FIRST H.P. TURBINE	
Output	1,300 s. hp.
R.p.m.	9,200
Steam pressure, inlet	1,780 lb.
Steam temperature, inlet	880 F
Steam pressure, exhaust	668 lb.
Steam temperature, exhaust	644 F
SECOND H.P. TURBINE	
Output	1,300 s. hp.
R.p.m.	9,200
Steam pressure, inlet	655 lb.
Steam temperature, inlet	644 F
Steam pressure, exhaust	213 lb.
Steam temperature, exhaust	428 F
CIRCULATING-PUMP TURBINE	
Output	260–360 hp.
R.p.m., normal load	9,200–10,100
SCOTCH-MARINE BOILER PLANT	
Superheated steam pressure	200 lb.
Superheated steam temperature	572 F
Feedwater-inlet temperature	210 F

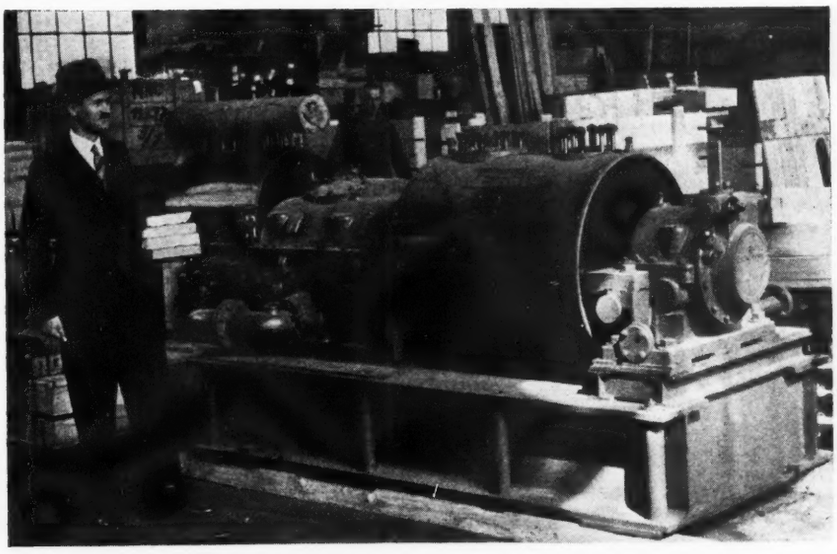


Fig. 4—1300-hp. turbine before shipment—9200 r.p.m., 1780 lb., 880 F—exhausts at 668 lb. and 644 F. Photo taken last year by Editor of Power in Escher-Wyss plant, Zurich, Switzerland

gases. Final heat recovery is effected by a Ljungstrom air heater placed above and in front of the boiler. The whole of the boiler proper is surrounded by a plenum chamber formed by a double casing, through which part of the air for combustion circulates. Boilers are fired through oil burners supplied with oil from a variable-speed, turbine-driven pump, speed being varied to suit boiler load.

The single evaporator drum, with its direct-connected steam circulating pump and turbine is shown in Fig. 3. Turbine and pump were made by Escher-Wyss. It should be noted that all steam generation takes place in this evaporator. The "boiler" (Fig. 2) contains no water and is merely a direct-fired superheater and economizer. The centrifugal steam-circulating pump (Fig. 3) draws the highly superheated steam into the evaporator, where it bubbles through the water, gives up its superheat and thereby generates additional steam.

The total weight of the Loeffler boiler installed is 53 tons, including radiant and convection superheaters, economizers, air heater, casing and steel work, fire brick, steam piping, heaters, etc., valves, fittings and burners, and evaporator drum with steam-circulating pump and turbine.

Feed water is delivered by one of two turbine-driven, high-pressure, 2-stage, centrifugal feed pumps. Running at 10,000 r.p.m. the H.P. stage is direct-connected. To avoid vaporization (at this high speed) of water delivered to the suction side from the deaerator, the first stage is geared to run at 3,000 r.p.m.

These changes have increased the steaming capacity of the ship by 13.5%, the power by 30%, and reduced unit fuel consumption 10%.

Treat an Air Compressor with Respect

Proper location, satisfactory foundation, good alignment, reliable lubricants, clean air source, protected piping and regular maintenance mean low cost

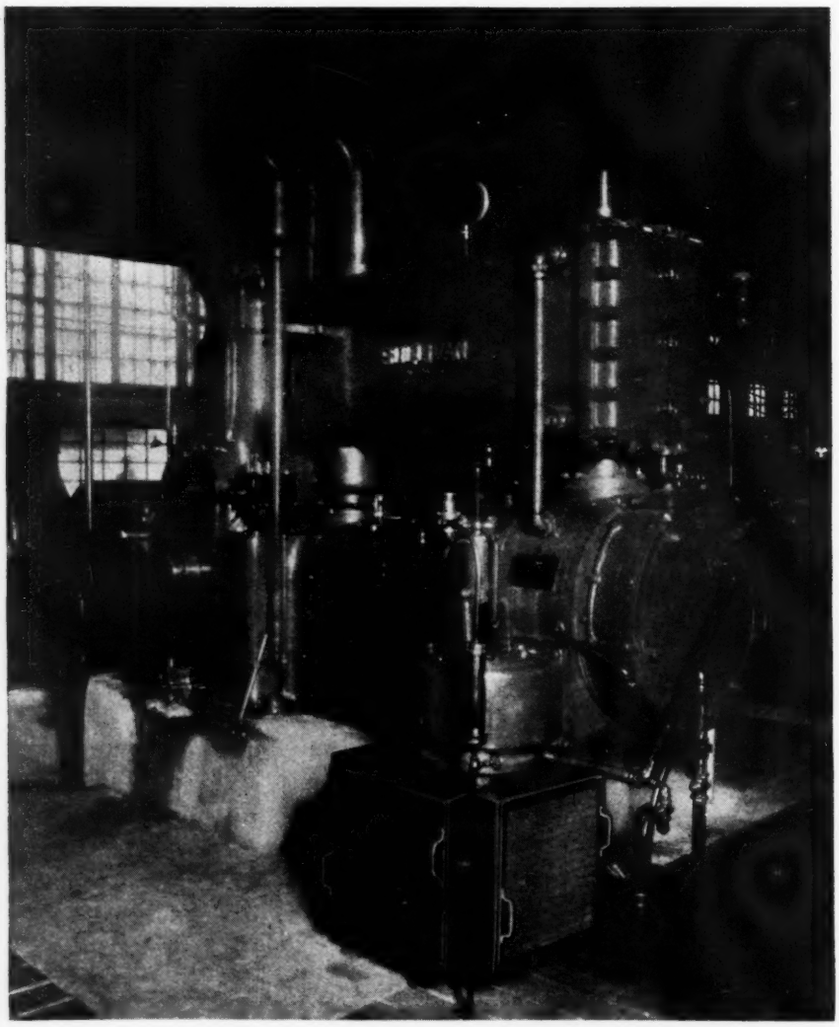
By J. M. Bartholomew
Engrg. Dept., Sullivan Machinery Co.

PROPER attention to operation and maintenance of stationary compressors mean low cost per unit or product just as it does for any other equipment. Most of the recommendations made here apply equally well to special installations, portable or semi-portable compressors and gas compressors, but discussion is limited to stationary installations.

Proper location, satisfactory foundation and housing are the first considerations when new air compressors are purchased and installed. Install compressors in the power house where they will be supervised by competent operating men, even though main piping can be made shorter by placing compressors closer to where air is used. Provide a well lighted room or building free from dirt and excessive heat. For large compressors, an overhead crane for installation and repair work is highly desirable.

Installations will ordinarily be made under direction of the manufacturer's erection engineer, who will be responsible for proper leveling and alignment of parts, satisfactory adjustment of bearings, proper erection of piping and starting the machines. During the running-in period, the crosshead, main and connecting-rod bearings and piston-rod packings may require some adjustment. Remove bearings that run hot, examine and scrape them to a proper fit. On crossheads and main bearings, friction horsepower can be increased materially by making them too tight, even though they do not feel unduly warm to the hand. The time that the machine continues to roll after pressing the motor-stop button gives a fair indication of no load friction if the machine is completely unloaded when the stop button is pushed.

Three unit air filters on the intake of a large angle-compound compressor keep grit and dirt from getting into cylinders and compressed-air system



Most stationary compressors have their main- and connecting-rod bearings lubricated by either splash or force-feed systems which draw from an oil supply in the crankcase. This lubricant should be a high-grade crankcase oil, purchased from a reliable supply house or oil company. Reputable oil companies distribute reliable information recommending brands of oil for different types of machines for all operating conditions. If the compressor is installed where dirt and grit are present in air, change or filter crankcase oil frequently. Keep all water and steam piping tight to prevent leakage into crankcase.

What Oil

Oil used in air cylinders is very important in the successful operation of compressors, and the oil companies have developed special oils for this service. Obtain specific recommendations covering air-cylinder lubricating oil from the company supplying oil to the plant. Adjust amount of lubricant used so that cylinder liners and valves will have an oily feel, but not enough to cause excessive carbon formation on valves.

Because of dirt, cinders, etc., suspended in the air around most industrial plants, filtering intake air to compressors is necessary. In one case, investigation revealed handfuls of dirt and dust in the intake air pipe. An air filter was installed and after six months operation, no valve trouble had developed.

Excessive dirt or grit in the air not only causes valve trouble but com-

bines with lubricating oil to form a grinding compound which rapidly wears cylinder liners, pistons and piston rings. Some of the dirt and grit will be carried in the air and cause rapid wear of pneumatic tools.

Several types and makes of air filters are now available, all designed for easy cleaning, which should be done at regular intervals to keep them in first-class operating condition. Viscous-type filters should be washed and dipped in the liquid furnished by the manufacturer, in accordance with directions sent with them. Dry-type filters should also be maintained in accordance with manufacturer's instructions. If vacuum cleaners or other auxiliary items are used, they will quickly pay for themselves in reduced maintenance cost.

It is very important that air-filtering equipment be kept clean and in proper condition to insure maximum protection to the compressor against undue wear. Even the best of air filters cannot be expected to give continued satisfactory service unless inspected regularly and maintained in good operating condition.

Position the air intake to obtain a cool dry air supply, far removed from

A 1,500-c.f.m. hanging-type filter on 12-in. intake pipe to air compressor in a metal-working plant

steam exhaust, smoke stacks or general dust and dirt conditions. Make sure that rust holes do not appear in the intake duct, for they will serve as an entrance for dirt or moisture. Keep inspection covers in place and properly gasketed. If the intake pipe passes through a cool basement where water vapor in the air may condense out, provide for collection and removal of water.

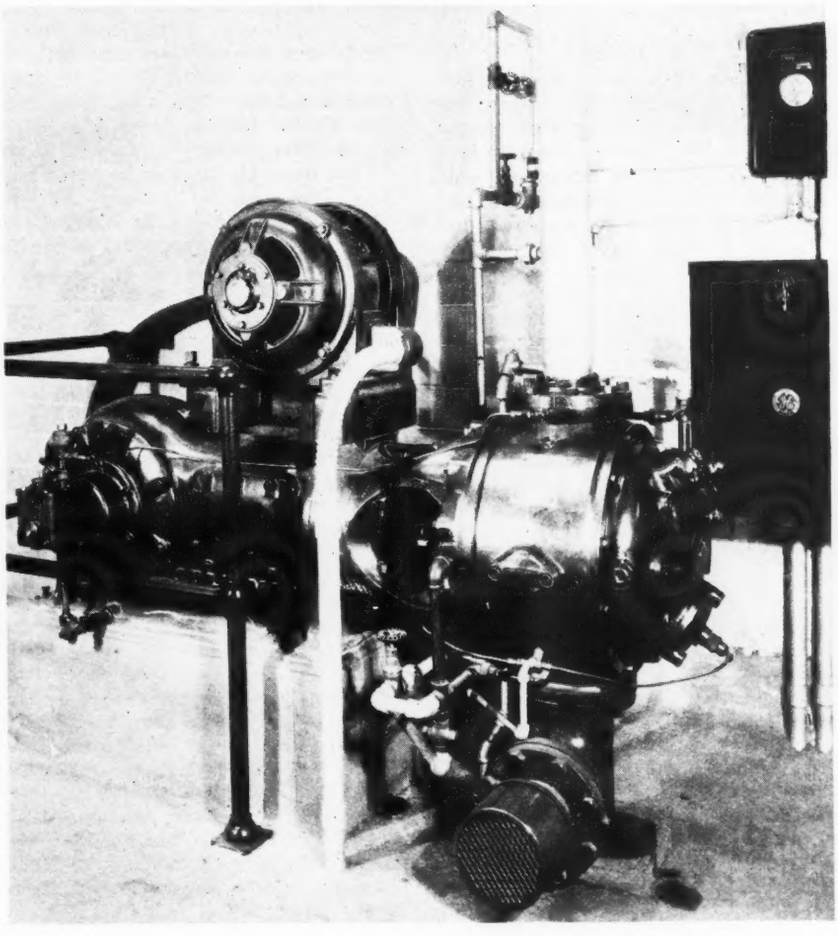
Examine cylinders regularly, say at 6-month periods, to make sure that their walls are being properly lubricated and that grit or dirt is not causing wear or scoring. Overhaul machines at regular intervals and check pistons and cylinders for size. If a cylinder liner has been damaged, hone the damaged area smooth; otherwise piston or piston-ring scoring will result and serious damage to the compressor may follow.

Replace piston rings when they become worn to a breakage danger point, or when blow-by exceeds normal. Regularly clean air passages in cylinder jacket and intercooler to prevent accumulation of dirt and sludge that may interfere with proper air flow and prevent normal operation of the cooling system.

Arrange air-discharge piping to give as direct a path as possible from compressors to aftercooler or receiver. Indicator cards taken on discharge piping with indicator motion actuated from air at the compressor crosshead will show whether or not excessive pulsations in the discharge line are causing power losses. On one installation, indicator cards showed a pulsation in the discharge line which built up terminal pressure to 130 lbs. when the average pressure in the line was 100. These pulsations represented about 30 hp. excess load on a machine requiring normal power of 350 hp., and were eliminated by placing a surge chamber in the discharge pipe near the compressor.

Discharge pipes should always be supplied with safety valves if there is a shut-off valve between compressor and receiver. To prevent build-up of excessive pressures, the safety valve should be at least half the diameter of the discharge line.

Small heavy-duty industrial air compressor, equipped with air filter on its intake and installed in clean well-lighted place



Air Temperature

Normal air-discharge temperatures from the compressor are well below the flash point of air-cyl. oil, particularly since flash point raises as pressure increases. Sometimes the discharge-air temperature becomes dangerously high because of valve failures, failure of cooling-water supply or clogging of the cooling-water system.

Safety devices are available that operate when a dangerous temperature condition is reached. The simplest device, the fusible plug, melts on excess temperature and allows air to escape with a whistling noise, thus warning the operator. Temperature relays may be used to sound a warning signal or to shut down the machine. Such safety devices are necessary where machines have been installed with very little supervision, but may be omitted in many cases where compressors are under supervision of experienced operators.

Air-Conditioning Dominates A.S.H.V.E. Meeting

Heating and ventilating engineers, meeting at Swampscott, Mass., learn of practical advances in the art of controlling atmosphere for human comfort. "Degree-day" unit proposed for hot weather as well as cold

ON JUNE 24, the American Society of Heating & Ventilating Engineers began its 3-day semi-annual meeting at the New Ocean House at Swampscott, 20 miles northeast of Boston. More than half of the papers dealt with air conditioning, the modern offshoot of the old art of heating and ventilating. The A.S.H.V.E. annual meeting will be held in New York City, Jan. 24-29 in connection with the National Heating and Ventilating Exposition.

Among contributions in the field of controlled atmosphere were: "How Much Power Will an Air-Conditioning System Use?" by Anson D. Marston, Kansas City Power & Light Co.; "Performance of Fin-Tube Units for Air Cooling and Dehumidifying," by Profs. G. L. Tuve and C. A. McKeeman, Case School of Applied Science; "The Adaptability of Precooling Coils to Air-Washer Systems," by John Everetts, Jr., Air & Refrigeration Corp.; "Study of Summer Cooling in the Research Residence Using Water at 52 F and 46 F," by A. T. Kratz (research prof.), S. Konzo (special research associate) and E. L. Broderick (research asst.), all of Engineering Experiment Station, Univ. of Ill.

Degree Days for Summer

In the long run, this meeting's most significant contribution may well be that of Mr. Marston. He proposed, with supporting evidence, a "degree-day" basis of figuring summer cooling. This was based on a statistical study of the energy consumption of 72 air-conditioning customers of Kansas City Power & Light Co., during 1934, 1935 and 1936.

Customers as a whole, and each major class, showed a fairly definite straight-line relationship between average monthly temperature and the kilowatt-hour consumption per month per installed horsepower of air-conditioning equipment. Humidity seemed to have little effect upon energy use, perhaps because most customers operate their systems by dry-bulb temperatures alone. Customers analyzed were operating on special air-conditioning meters, connected for the period from May to October.

Mr. Marston figured the degree-days for any month by subtracting 65 from the average monthly temperature and multiplying the difference by the number of days in the month.

The constant obtained for the Kansas City conditions indicates, for all

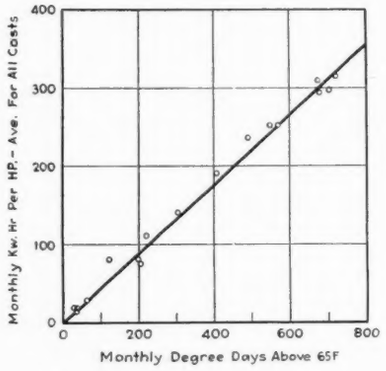


Fig. 1—Energy consumption vs. degree days, all customers

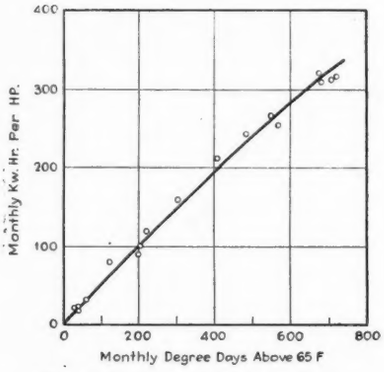


Fig. 2—Energy consumption vs. degree days, commercial customers

customers, about 0.42 kw.hr. per month per horsepower per monthly degree-day above 65 F, Fig. 1. The corresponding constant for commercial customers is about 0.46, Fig. 2.

Coils Analyzed

The paper of Profs. Tuve and McKeeman produced lively discussion, mostly favorable. They pointed out the great confusion existing among various methods of predicting the performance of fin-tube units for air cooling and dehumidifying, and then outlined the experimental work under way at the Case School and conclusions to date.

In the discussion it was suggested that the inside and outside performance of tubes should be considered separately to permit using existing data on water-side coefficients. Several discussers decried the tendency to make all kinds of doubtful assumptions when figuring or selecting coils. One pointed out that selecting and rating are two different matters. Rating must be done by the manufacturer. With the aid of curves and tables supplied by the manufacturer, the user should be able to select coils without computation. The need for a unified method of rating, giving the user simple over-all heat-transfer coefficients, was urged.

Coils Versus Washers

John Everetts, Jr., compared the advantages and disadvantages of cooling coils and air washers. A combination of the two, said Mr. Everetts, is often better than either alone. The chief advantage of the saturation-type air washer, with reheat, is precise control. First, the desired absolute moisture content is obtained by saturating the air at a predetermined temperature. Then dry-bulb temperature is controlled exactly by reheating.

A good commercial air washer to do the dehumidifying, cooling and saturating in an industrial installation will require about 12 to 15 g.p.m. of spray water per 1,000 c.f.m., with a temperature rise in the water of 5 to 6 F. Spray-nozzle pressures of from 18 to 30 lb. are necessary to atomize the water. A cooling coil has entirely different characteristics. Assuming constant air velocity, the leaving condition of the air will vary with a change in either dry-bulb, wet-bulb, water velocity or total heat removal.

In spite of the many variables encountered in the proper design of a cooling system, coils have certain advantages over spray-type dehumidifiers, said Mr. Everetts. Counterflow operation of a cooling coil means that the water-leaving temperature may be higher than the air-leaving temperature. This is not possible with an air washer, which gives the coil the advantage of a higher suction pressure on the refrigerating system and may make it possible to use well water. On the other hand, certain industrial applications require removal of soluble impurities which cannot be taken out by filters or cooling coils. An air washer may solve the problem. The author described a combination air washer and coil having the advantages of both.

In its Pittsburgh experiment station, the U. S. Bureau of Mines houses the A.S.H.V.E. Research Laboratory. Data of great practical importance have been developed there. Among contributions

of the laboratory to the semi-annual meeting was "Heating Requirements of an Office Building as Influenced by the Stack Effect," by F. C. Houghten, director of the laboratory, and Carl Gutberlet, research assistant.

Because of the stack effect, it was found, cold air flows in through every crack and crevice on the lower floors, passes through the building, and outward in equal mass through the cracks and crevices in the windows and walls of the upper floors. Every pound of outside air entering the lower part of the building must be heated to 70 F to maintain room temperature. On the other hand, air leaking into rooms in the upper part of the building from floors below does not need to be heated up before leaving.

Direct Radiators Versus Convecters

There have been many arguments over the relative effects produced by heating a room to a given temperature in different manners. Profs. Kratz, Fahnstock and Mr. Broderick of the University of Illinois reported the results of elaborate tests (A.S.H.V.E. in cooperation with the University) comparing the operation of different types of direct steam radiators and convecters. The set-up included an elaborate testing room and an instrument called the "eupatheoscope," designed to simulate the human body in its reaction to room temperature and to give, therefore, the "effective temperature."

Among conclusions were:

1. For winter service, and a given room temperature at the 30-in. level, convecters use less steam than direct radiators, but produce an effective temperature 1.3 to 2.2 F lower. This largely offsets the saving in steam.

2. Rooms heated with heavy direct radiators cool more slowly when the steam is turned off.

3. The rate of cooling is also greatly influenced by the heat capacity of the material in walls, floor and ceiling.

A.S.T.M. Stresses Coal

AMONG the many papers presented at the 40th Annual Meeting of the American Society for Testing Materials, held in New York City June 28-July 2, were several of interest to power engineers. These papers, which may be obtained in complete form from Society headquarters, 260 S. Broad St., Philadelphia, are summarized here.

The Significance of Ash-Softening Temperature and Ash Composition in the Utilization of Coal, by A. W. Gauger. Summary: The importance of ash fusibility as measured by the standard A.S.T.M. ash-softening temperature test has been overemphasized. Had there been no coal with highly refractory ash, the problems incidental to ash disposal (clinkering, etc.) would have been solved by equipment design, which is what will have to be done ultimately.

Technique in the Determination of Dissolved Oxygen, by T. H. Daugherty. Summary: The author believes the Schwartz and Gurney double-titration B modification, with several recommended changes in procedure, to be the most satisfactory. A detailed discussion of the theory and procedure of this determination method is presented. Emphasis is placed on the careful technique necessary in the determination of traces of dissolved O_2, and recommendations are made for comparative tests for all methods, for further investigation of electrometric titration and for determining permissible limit in the sample of such contaminants as nitrite and sulfite.

Significance to the Consumer of Sulfur in Coal, by Hen Kreisinger. Summary: Sulfur and ir n, with which sulfur is combined, are likely to lower softening temperature of the ash, Fig. 1, and thereby cause clinker in the fuel bed, slagging of furnaces and slagging and fouling of heating surfaces. When high-sulfur coal is burned on grates, either in hand- or stoker-fired furnaces, clinker troubles are usually less serious if pyrites occur in large lumps than when they are uniformly distributed through the coal. The large lumps, being heavier than coal, sink to the grate out of the high-temperature zone during the process of combustion, and may not reach the softening point.

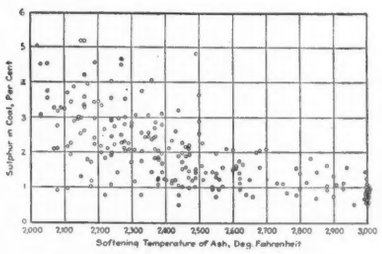


Fig. 1—Relation between percentage of sulfur in coal and softening temperature of ash. (Pennsylvania coals)

Products of oxidation or decomposition of sulfur compounds in coal are corrosive, and may cause rapid deterioration of metallic parts. Incidentally, fouling and corrosion of economizer and air heater are usually more serious with high-sulfur fuel oil than with high-sulfur coal, which is probably due to the higher percentage of hydrogen in the oil. This forms more water during combustion, which in turn combines with SO_3. High-sulfur coal does not store well. Slow oxidation of sulfur lowers the coal heat value and increases danger of spontaneous combustion.

Interpretation of Laboratory Coal Tests—Proximate Analysis and Calorific Value, by G. B. Gould. Summary: This relates laboratory coal tests to the variety of conditions to which coal is subjected to in use and to the many factors that may introduce variations. The fact must not be lost sight of that coal is a variable product.

Effect of Temperature on the Properties of Metals, report of a joint research committee. Summary: This, a progress report, presents revision on proposed new test methods for metals and includes a report on long-time creep tests of 18% chromium, 8% nickel steel and steel with 0.35% carbon content.

Corrosion of Iron and Steel, report of Committee A-5. Summary: Also a progress report, dealing with proposed revision of standards, most of which concern wire in the form of fencing, galvanized and barbed wire, etc.

Non-Ferrous Metals and Alloys, report of Committee B-2. Summary: Proposed tentative specifications for rolled zinc, which includes coils or sheets cut from strip-rolled zinc, pack-rolled zinc, and zinc plates produced by any rolling method.

Pulverizer Performance as Affected by Grindability and Other Factors, by Martin Frisch and A. C. Foster. Summary: Relative ranking of coal on its pulverizing characteristics depends on the method used. No two methods assign the same relative rank to the same coal. Relative ratings derived from properly standardized tests of commercial pulverizers rank coals closer together than standard laboratory tests. Laboratory grindability ratings are useful, and may be used to predict the performance of a pulverizer on coal of known grindability without test, but only provided that the grindability-capacity relationship for the pulverizer has been previously determined, and effects of such factors as feed size, moisture and fineness are taken into consideration.

Laboratory Tests Relating to Caking, Plastic, Gas- and Coke-Making Properties of Bituminous Coal, by O. O. Malleis. Summary: This is a description of various tests, including the coke button from volatile matter, agglutinating-value, resistance to gas flow, swelling, plastometer and expansion during coking tests, which are becoming more important in determining heretofore little known data on bituminous coal.

Steel, report of Committee A-1. Summary: Also a progress report on various revisions and new proposed specifications on alloy-steel and steel plates, tubes, etc.

Speaking of Power

A.S.H.V.E. knows how to pick the right spots for its summer conventions. For example, Buckhill Falls, Pa., last year and Swampscott, Mass., this year. . . . The Swampscott affair was just the right combination of work and play. Working hard in the mornings, the delegates saw New England at its best in their recreational afternoons.

. . . Work and play

Many engineering societies and associations now hold their summer meetings in spots away from the noise, dust and heat of the cities. In my opinion, the meetings that mix work and play get just as much accomplished as if nothing but work was scheduled. All work and no play makes Jack a dull boy. Not only that; when the specialists "let down their hair" on the golf links, as they used to in the old swimming hole, they get to know each other better and pick up tips and sidelights that never reach the surface in formal technical sessions.

In spare moments at Swampscott I made it my business to sit down on the hotel veranda with some real experts to get the "lowdown" on air conditioning as they saw it. Some of the thoughts picked up there, and elsewhere, I have set down on page 450. . . . The point that sticks in my mind beyond all others is that air conditioning never can be an exact science. Undoubtedly the proper equipment, properly operated, can produce any specified temperature and humidity in a room. But how can you decide scientifically what to specify? As one man told me, "If you don't get any kicks about the room being too hot, you can be sure it is too cold, and vice versa."

. . . Sit on the veranda

Our report of the A.S.H.V.E. meeting (page 450), covers the very significant paper presented by Anson D. Marston of the Kansas City Power & Light Co. The outstanding thing in his paper was the proposal that the "degree-day" system, now widely used to study heating loads, be used also for air conditioning. Here's something worth thinking about; perhaps readers will want to collect experience and compare it with Mr. Marston's.

Writing on the same subject in the May number of the *Edison Electric Institute Bulletin,* Mr. Marston brought out other points of great interest. Already, the national utility air-conditioning connected load is probably 600,000 hp., and growing by leaps and bounds. Will the whole utility rate and load structure be turned topsy-turvy by air conditioning? Will system peaks eventually come in summer instead of winter? Mr. Marston thinks it likely, particularly in the southern cities with moderate industrial loads. Remember also that electrical equipment has a lower kva. capacity in summer and that warmer condensing water cuts turbine capacity. . . . Mr. Marston warns utility engineers that the air-conditioning baby has already grown into a hulking big kid. His perambulator is getting topheavy.

. . . Topheavy perambulator

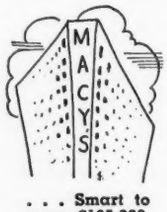
Just now it's the style to put a high-pressure "top" on your old plant. The excuse, of course, is that this is a cheap way to turn the inefficient old plant into a bigger plant of 1937 model—almost. One engineer claims his "top" will save over half a million dollars a year. It will, too. That is, compared with a complete new plant, including a new building.

Today a crop of "tops" is growing in every utility backyard. Some are already ripe. It will be a good idea to look them over before deciding what to plant next year. Already, it is evident that the tops have cost more than was estimated in most cases, although not as much as some of the pessimists feared. . . . An engineer friend has hinted to me that other possibilities should be looked into. He reminded me that a top and a new plant are not the only possible choices. After all, the old cast-iron low-pressure turbine shell is what the Bible would call an "old bottle." Is it really worth while to pour into it the new wine of the high-pressure top? This man thought it might have been cheaper in some cases to buy an extra low-pressure turbine shell and condenser, hitch it up to the same or another generator and thereby avoid spending a lot of money in making the rest of an old plant suit a new condition of operation, compromising at every turn. This would still salvage the existing dock facilities and building, and the owner wouldn't have to live with a cast-iron turbine for the next ten or twenty years. . . . Whether or not this is a sensible comment, one thing is sure; the topping style cannot continue indefinitely. In a few years practically all of the low-pressure plants worth topping will have their new bonnets.

. . . Crop of tops

Speaking of tops, the subject is well represented in this number of *Power,* as in previous numbers. Central station readers will be particularly interested in the comments of *Frank S. Clark,* of Stone & Webster (page 426), and the discussion of the operation of topping turbines at light loads (page 444).

Articles published in *Power* from time to time over a period of years give a complete power history of the R. H. Macy department store, New York. Latest developments at Macy's are covered on page 422 of this number. Through a great variety of coordinated economies this progressive concern is now generating its own power at a net saving of $166,000 per year, considering all costs on both sides of the fence. . . . Here's another interesting slant: From 1924 to 1936, Macy's yearly output increased 160 per cent (170 per cent including the air conditioning turbines) yet the fuel-oil consumption increased only 63 per cent.

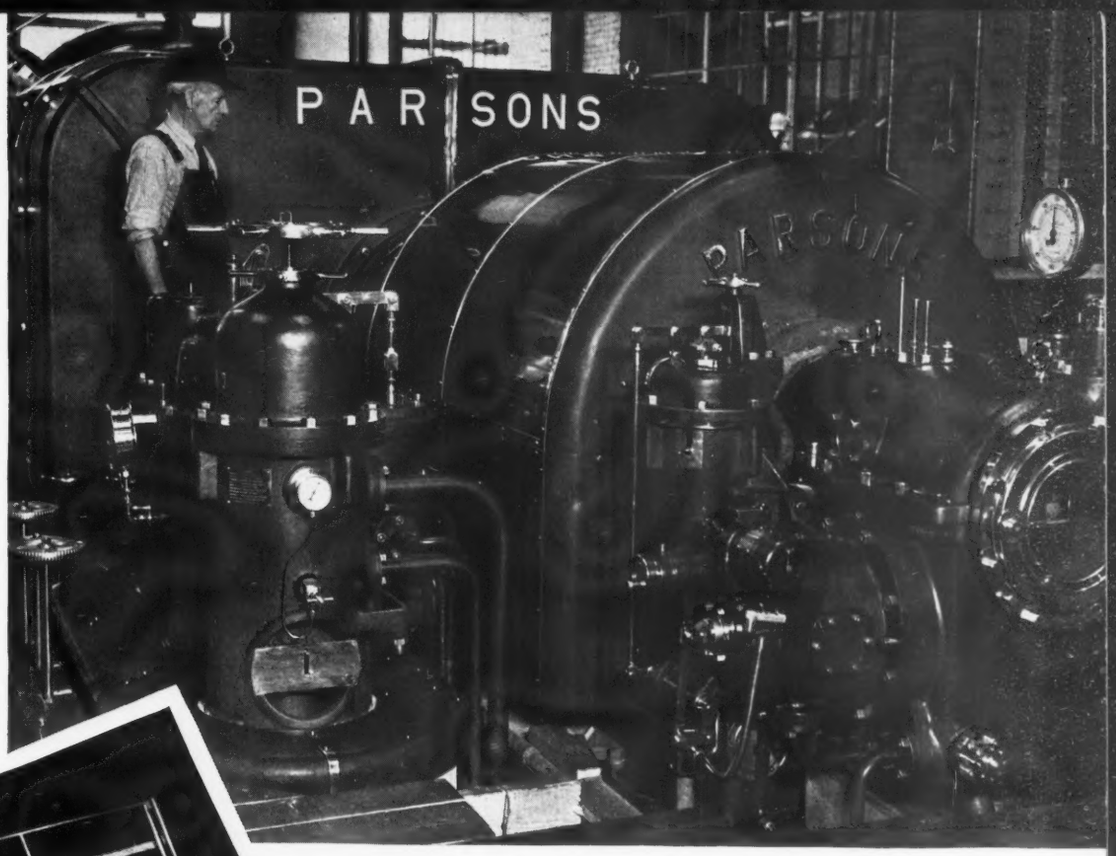


. . . Smart to save $165,000

PHIL SWAIN
Editor

RIGHT

This new 5,000-kw., 3,600-r.p.m. turbine exhausting at 200 lb., is a topping unit for the 10,000-kw. machine behind it, and was placed between the older 10,000-kw. and the 5,000-kw. unit now removed



BELOW

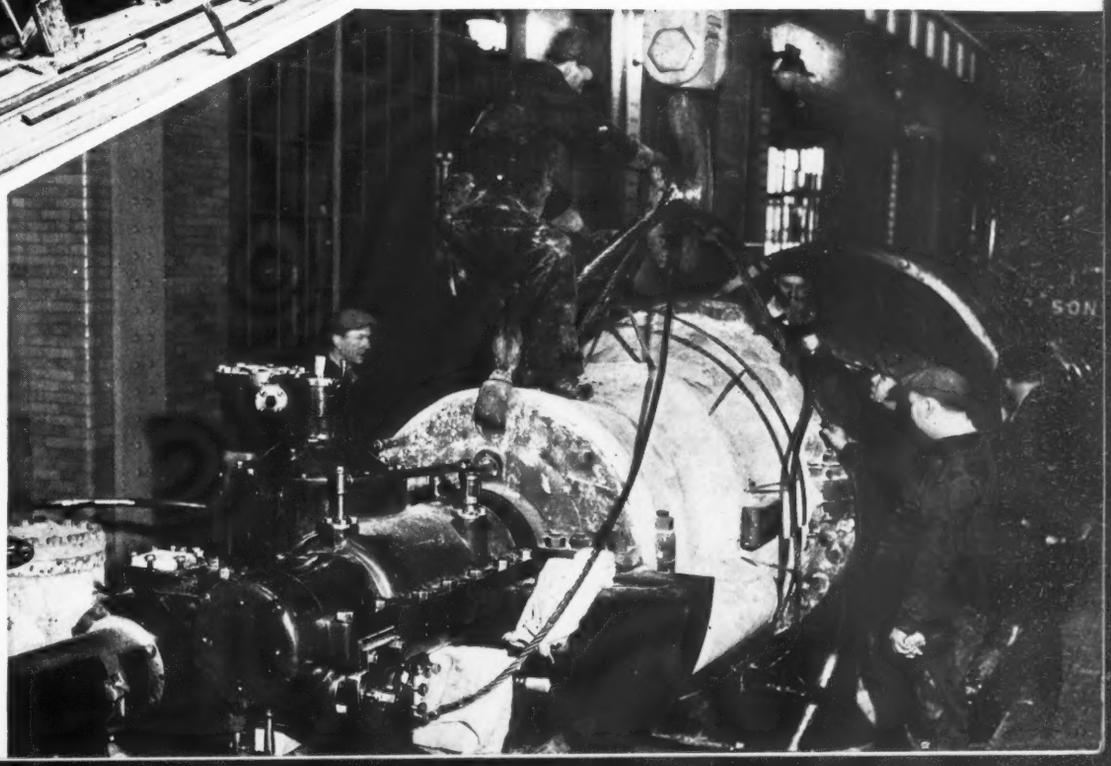
Into this space goes the 20,000-kw. unit. At top can be seen the new 5,000-kw. unit which took load April 1. Two of the four new 820 lb., 900 deg., 165,000-lb. per hr. boilers are now in operation, and the old No. 2 is being removed to make space for the third, No. 3 will have a hydraulic coupling on the ID fan drive instead of the vane control on earlier units

Same Space

Ford of Canada, at Windsor, Ont., is installing a 20,000-kw. turbine in the space once occupied by a 5,000-kw.

RIGHT

Tearing down the old 5,000-kw. turbine to make space for the new 20,000-kw., 3,600-r.p.m., double-extraction condensing-type machine now being installed. It will be bled at 200 lb. for process, and 7 lb. for heating, extra steam going to the all-welded condenser



Complete details of the "topping" program at Windsor appear in POWER for August, 1936, pages 424–426

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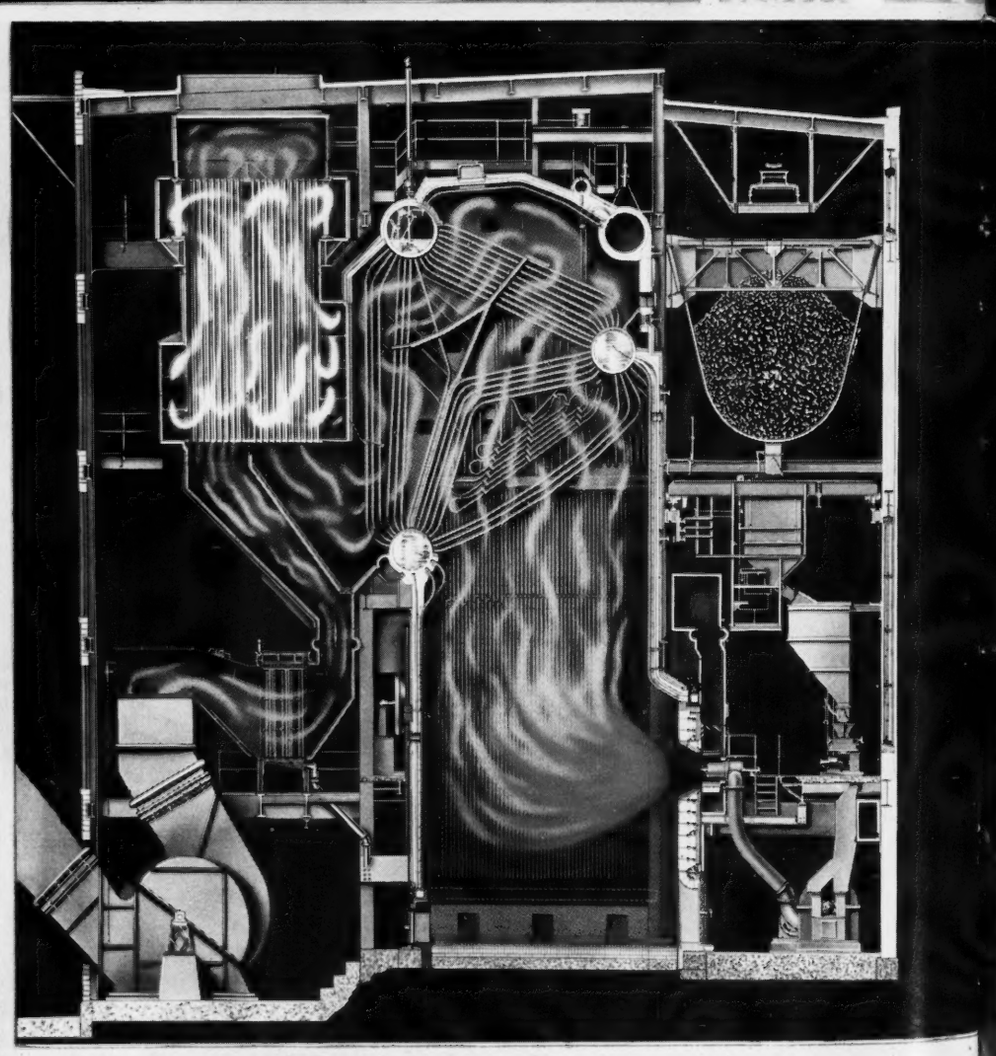

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~~12~~ 14 orders has placed with RILEY in 9 years

A Record that tells a story of the satisfactory performance of Riley Equipment

2-~~1~~—375,000 lbs./hr. Unit for Covington, Va.
2-~~1~~—375,000 lbs./hr. Unit for Luke, Md.
2— 71,500 lbs./hr. Units for Williamsburg, Pa.
2—225,000 lbs./hr. Units for Charleston, S. C.

Westvaco has placed the following orders with Riley

LUKE, MD.

Nov. 17, 1927	2—No. 4 Pulverizers and Burners
May 15, 1928	4—No. 4 Pulverizers and Burners
Nov. 1, 1928	4—No. 4 Pulverizers and Burners
Dec. 20, 1929	2—No. 4 Duplex Pulverizers and Burners
Dec. 2, 1933	1—375,000 lbs./hr. Steam Generating Unit
	3—No. 4 Duplex Pulverizers and Burners
April 9, 1937	1—375,000 lbs./hr. Steam Generating Unit

COVINGTON, VA.

Jan. 15, 1929	1—No. 4 Pulverizer
Nov. 9, 1933	1—375,000 lbs./hr. Steam Generating Unit
	3—No. 4 Pulverizers and Burners
April 16, 1936	2—No. 4 Pulverizers
May 28, 1937	1—375,000 lbs./hr. Steam Generating Unit

TYRONE, PA.

April 24, 1929	5—No. 4 Pulverizers and Burners
June 25, 1936	Water Walls for existing boilers

WILLIAMSBURG, PA.

Feb. 3, 1936	2—71,500 lbs./hr. Steam Generating Units
	3—No. 4 Pulverizers and Burners

CHARLESTON, S. C.

June 30, 1936	2—225,000 lbs./hr. Steam Generating Units
	4—No. 5 Pulverizers and Burners

Complete satisfaction from previous installations is the sole basis for placing repeat orders. The fact that West Virginia Pulp & Paper Company has placed ~~twelve~~ fourteen different orders with Riley in nine years, thoroughly indicates that Riley Stoker Corporation and Riley equipment has entirely fulfilled West Virginia Pulp & Paper Company's expectations as to performance, service and handling of previous orders.

It is because of the satisfactory performance of Riley Steam Generating Equipment, that there has been such a decided swing to Riley . . . why Riley sales in 1936 far exceeded all previous sales records. Riley's star is definitely in the ascendency. A visit to a number of Riley installations will clearly give you the reasons why.

The performance of recent Riley installations assures you the same type of satisfactory installation when you order Riley equipment. When considering steam generating or fuel burning equipment be sure to call on Riley.

RILEY

STOKER CORPORATION - WORCESTER, MASSACHUSETTS

BOSTON NEW YORK PHILADELPHIA PITTSBURGH BUFFALO CLEVELAND DETROIT TACOMA BALTIMORE
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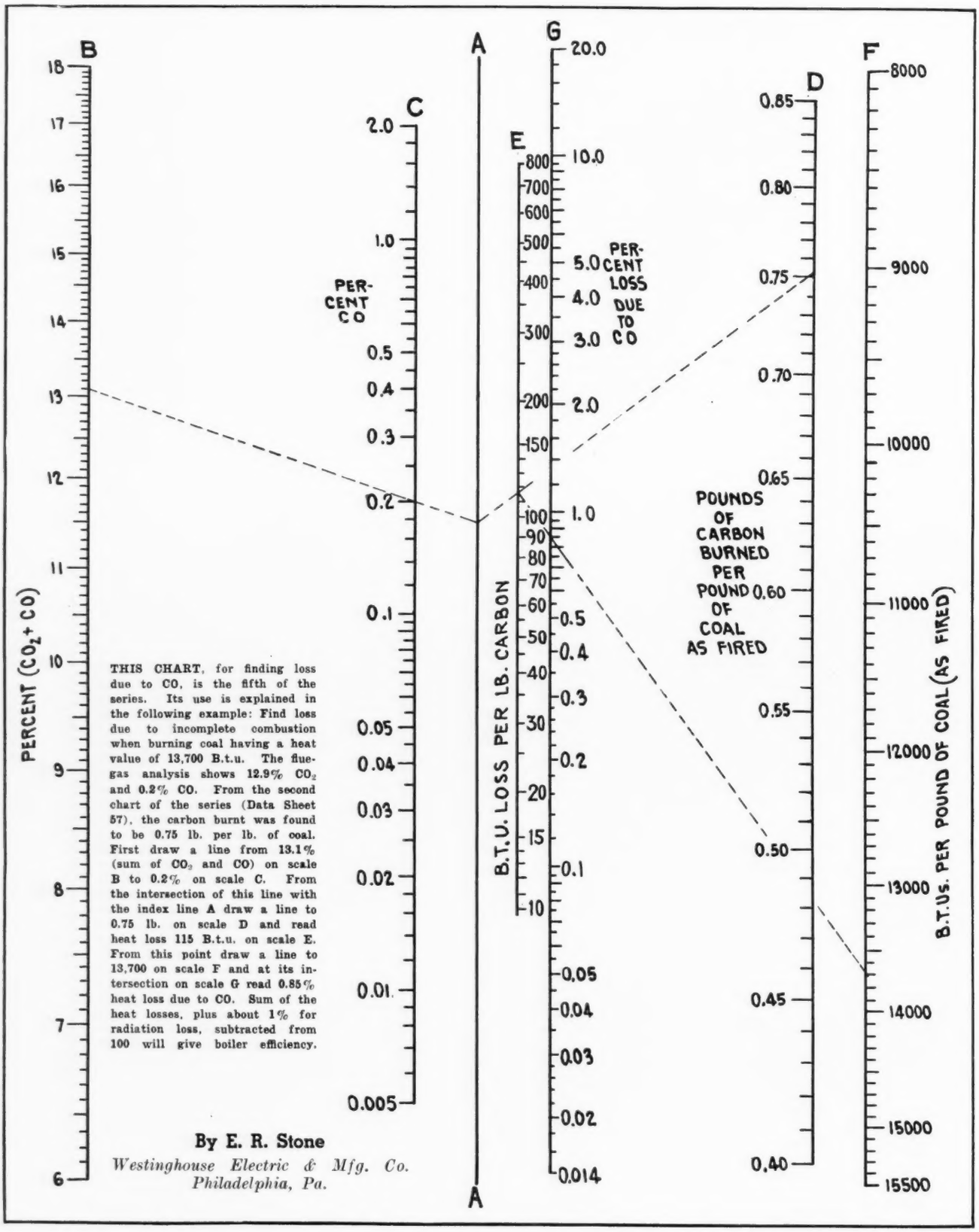
COMPLETE STEAM GENERATING UNITS

BOILERS - SUPERHEATERS - AIR HEATERS - ECONOMIZERS - PULVERIZERS
BURNERS - STOKERS - WATER-COOLED FURNACES - STEEL CLAD SETTINGS

Number 60

LOSS DUE TO CO



THIS CHART, for finding loss due to CO, is the fifth of the series. Its use is explained in the following example: Find loss due to incomplete combustion when burning coal having a heat value of 13,700 B.t.u. The flue-gas analysis shows 12.9% CO_2 and 0.2% CO. From the second chart of the series (Data Sheet 57), the carbon burnt was found to be 0.75 lb. per lb. of coal. First draw a line from 13.1% (sum of CO_2 and CO) on scale B to 0.2% on scale C. From the intersection of this line with the index line A draw a line to 0.75 lb. on scale D and read heat loss 115 B.t.u. on scale E. From this point draw a line to 13,700 on scale F and at its intersection on scale G read 0.85% heat loss due to CO. Sum of the heat losses, plus about 1% for radiation loss, subtracted from 100 will give boiler efficiency.

By E. R. Stone
Westinghouse Electric & Mfg. Co.
Philadelphia, Pa.

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Power for the Navajos

Butane-propane gas, at 2,800 B.t.u. per cu. ft., is the fuel, and cooling water must be brought for 20 miles by tank truck, to this Indian power station

By James F. Maher

Assistant Engineer, Shiprock Power Plant, U.S. Indian Service, Shiprock, N. M.

INTO the colorful Southwest, land of petrified forests, sand, sagebrush, and vivid beauty, has come the white man. With him he brought his desire for electric power even into the Indian reservations.

On the Navajo Reservation, in the Northern Sub-Agency, is the year-old Shiprock power plant, furnishing power and light to the Sub-Agency and school, and to five pumping stations for irrigation. If you have a map handy, look in the northeastern corner of New Mexico. In conjunction is a butane-propane gas-distribution system taking gas from the power-plant vaporizing system, to supply heating and cooking gas for residents, and a gas-bottle and truck-filling station, the trucks carrying gas to the million-dollar Navajo Central Agency at Window Rock, Ariz., to be used in the gas-distribution system there.

Butane-propane gas, also called liquid petroleum gas, is a waste gas from the oilfields, usually disposed of by burning or pumping back into the ground. Its specific gravity is 1.6 at standard conditions, and its calorific value 2,800 B.t.u. per cu.ft., with the mixture 40% butane, 40% propane and the rest ethane and pentane. The gas can be liquefied under slight pressure, and in this way is transported like water or oil, but under atmospheric conditions it is a vapor.

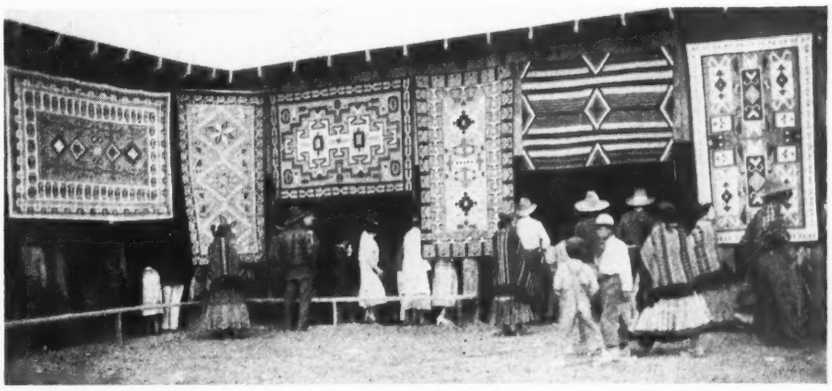
The Power Plant

Prime movers are two 6-cyl., 12½x 15 in., 350 hp. (sea-level rating,) 360-r.p.m., 4-cycle, Superior diesels direct-connected to 225-kva., 2400-volt, 60-cycle, 3-phase Electrical Machinery alternators. Each engine develops about 300 hp. at this altitude. Diesels must be converted for this fuel, which is neither like oil nor natural gas, and requires some special equipment and knowledge to burn successfully, Fig. 9. Gas mixers are of a special type, very sensitive to adjustment because a slight change in the amount of gas or air makes a much greater change in engine speed and temperature. Mixers must be adjusted to suit variations in the liquid gas.

There is also a 10-panel Electrical Machinery switchboard, Fig. 4, with panels for each engine, a blank panel for a potential third unit, separate panels for station power (2400 volts), 2400-volt distribution, 6900-volt distribution, street lighting, auxiliaries, etc.

Fuel comes from the Rattlesnake Field of Continental Oil Co., 8 miles away, by pipeline. It is stored at the plant in two 2800-gal. underground tanks. From these, it passes through a series of regulators and two heat exchangers (one a Braun) to insure complete vaporization and constant pressure, because of its tendency to freeze at low pressure and vaporize when released to the atmosphere. Then it goes directly to the engines and distribution system in an undiluted mixture. Atmospheric heat is absorbed so readily during the temperature drop that its moisture condenses on the outside of the piping, etc., and any moisture entrained in the gas promptly freezes in regulators and line unless the heat exchangers are used. During distribution, a little of the gas returns to the liquid form, and must be blown occasionally from low spots of the lines. The instability of the gas is also allowed for in filling the storage tanks not over two-thirds full, and in drawing off the fuel as a liquid from the tank bottom. With a top outlet, principally vapor would be drawn off, and the tank would soon fill with liquid, so that a temperature rise would have serious results.

Pressure at the Rattlesnake Field Storage is 175 lb., and at the power plant from 100 to 140 lb., varying with the percentage of liquid in the tanks. Every effort is made to keep liquid level constant, with a Mason-Neilan float control, to avoid variations. Liquid leaving the tanks is reduced



For nine days each October, more than 4,000 Navajos (Fig. 1), gather at Shiprock to make paintings in the sand. Each sundown the paintings are destroyed, each morning redrawn. The last three days of painting are the days of Yai-be-chai, the annual harvest or thanksgiving feast and dance. Navajo men, in teams of two, dance continuously for three days; there are races and rodeos, and Indian traders put on exhibits, Fig. 2. Last October a trimotor plane came to the Fair, and was kept busy taking up Indians and the white visitors

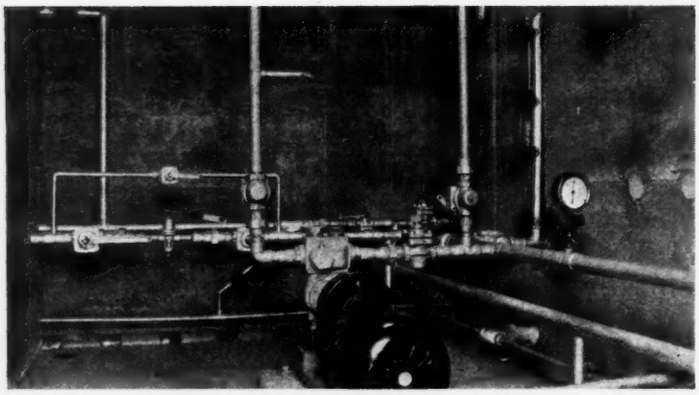


Fig. 3—Tank room, showing Harmon-Pacific pump in foreground (to fill truck tanks), driven through gear reducer by Leland motor. Main line to tanks at left, with line to vaporizing room behind it. Header and gage column of one tank at right

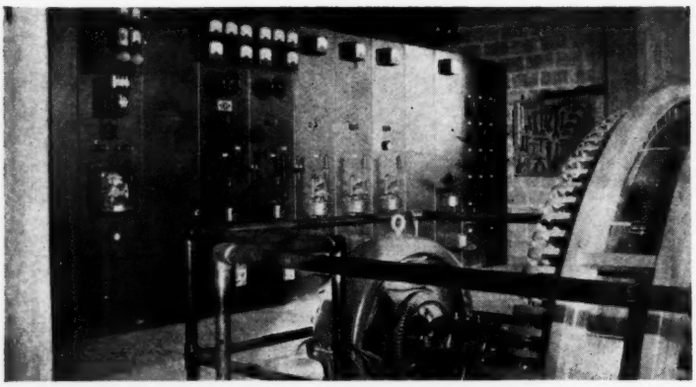


Fig. 4—Switchboard, with bus and generator voltmeters, synchroscope, frequency meter, Alnor pyrometer, and voltage regulator on No. 1 panel, blank No. 2 for possible third unit, Unit No. 2 panel, Unit No. 1 panel, 2400-volt distribution panel, 6900-volt transmission panel, 2400-volt station panel, blank, street-lighting panel, station-auxiliary panel

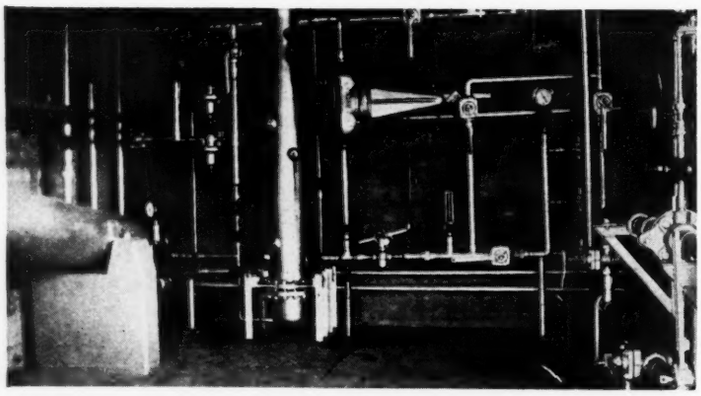


Fig. 5—One end of gas room. Vertical heat exchanger is No. 1, with liquid level control at its right. In right back corner are 1st-stage regulators (3 in multiple), Foxboro orifice meter in right foreground. Second heat exchanger horizontal at left, leading to last regulators and gas meter

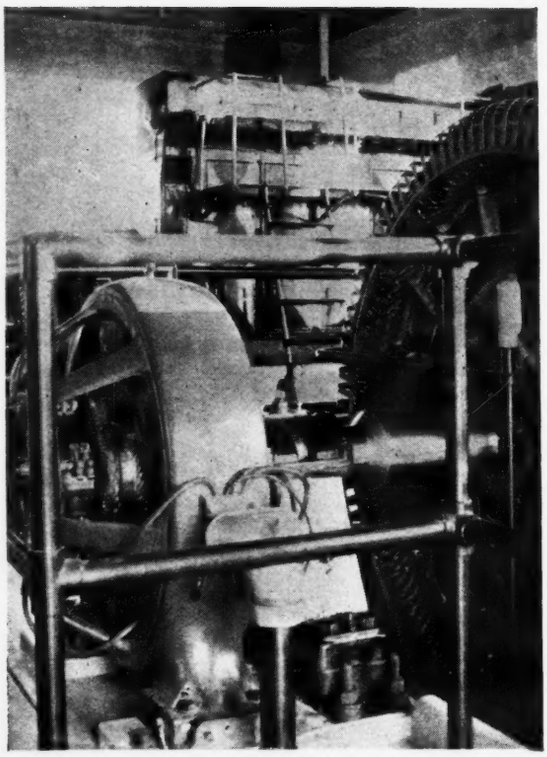


Fig. 6—Looking across generators from west entrance

to 100 lb. at the first regulator stage in the vaporizing room, then passed through a heat exchanger to the second regulator stage, then through the second heat exchanger, whence it emerges at 5 oz. pressure and 95 F.

Engine jacket water passes to a 30× 40-ft., louver-enclosed, spray pond incorporating two Schubert Christy heat exchangers each containing 96 $\frac{3}{4}$-in. O.D. copper tubes over which raw water sprays. Tubes are 12 ft. long and mounted horizontally, and have 225 sq.ft. of surface each. Raw-water is sprayed through 11 Marley nozzles per exchanger, three on each side, three in the middle, and two on one end. High summer temperatures have indicated that the present cooling surface is inadequate, because both exchangers are required for one engine on a hot day.

Jacket water is hauled 20 miles by tank truck from a well, then stored in a cistern here. About 200 gal. of makeup are required per month. Raw water is drawn from the Agency water system, which includes an intake system near the river. The six Dayton & Dowd water pumps are driven by Robbins & Meyers motors.

Piping System

All gas piping is Anaconda copper, with streamline (Mueller) soldered fittings. Even the 8-mile, 2-in. line from Rattlesnake Field is copper, to avoid corrosive action of the soil. Thus far, even in the worst places, the pipe shows only a slight scum and discoloration, while ordinary iron pipe would soon have been rendered worthless. As the liquid fuel leaves the Rattlesnake tanks, it is reduced to 150 lb. A drop of 300 ft. in the 8-mile line would create difficulties with static head, if it were not for an additional regulator midway of the line and another at the power-plant end. The line also includes five water traps at low points. These collect both water and any "heavy" liquid, and are blown off occasionally to prevent slugs from being carried into the tanks.

Expansion joints are of course more numerous than in iron pipe under ordinary conditions, because of the great expansivity of copper. Streamline U-type joints are used at each trap, wherever the line is exposed in crossing arroyos, and where it crosses the San Juan river. Traps were pitch-coated before covering. Because the gas is heavier than air and very inflammable, operators must always be extremely careful that no leaks occur anywhere along the line. Such leaks would permit vapor to collect in

pockets which require only a casual spark to cause a violent explosion.

Thus far, the pipeline has given no trouble. Welded joints and proper testing eliminated initial leaks, and the copper allows no sparks even when the pipe is struck. All valves are of the Crane lubricated-plug type.

In addition to the special fuel mixers at the engines, a number of other special parts are required. For example, exhaust-valve springs must be heavier, and of greater strength to withstand cylinder gas temperatures. Lighter springs apparently lose their temper in service, so that valves do not close properly. This permits warping of valve cages, with resultant shutdowns, regrindings and other troubles.

Since the plant was put in service in June, 1936, there has been no noticeable deposit of carbon on cylinder or piston heads. There is no unburned fuel after combustion, hence no crankcase dilution, thus oil changes are more infrequent and no makeup is required. A Goulds Hydroil centrifuge is used 22 hr. per day. Operating costs for January, with materials, tools and supplies high to take care of future needs:

Labor	$0.0175	per kw. hr.
Materials & Supplies	0.0027	per kw. hr.
Tools & Equipment	0.0035	per kw. hr.
Lubricating Oil	0.00019	per kw. hr.
Liquid Fuel	0.0072	per kw. hr.

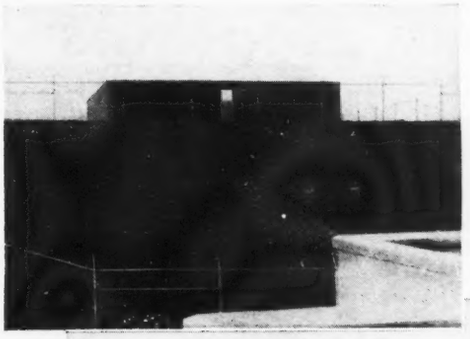
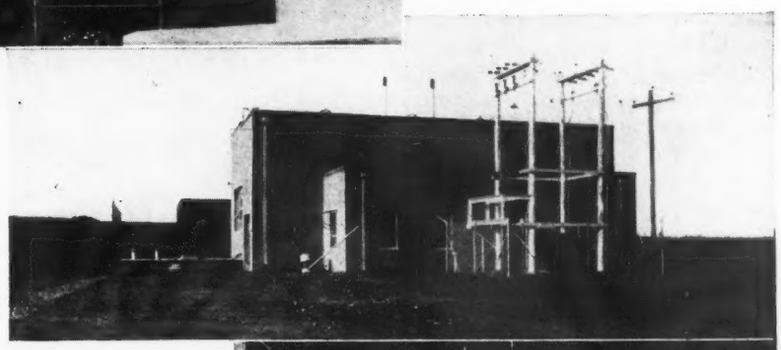


Fig. 7—Spray pond, photographed from gas-room steps

Fig. 8—Plant, from tank room, showing gas-room roof at left and spray pond in background



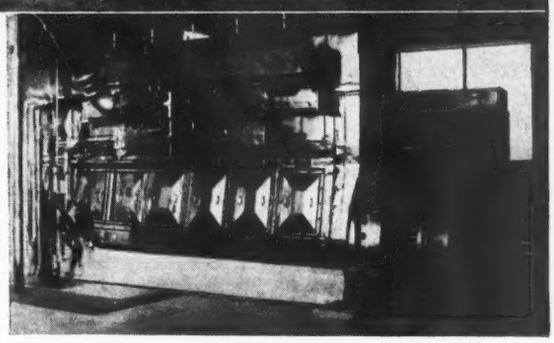


Fig. 9—No. 1 unit, showing mixer on end of vertical-pipe ell, two intake manifolds, and exhaust manifold

Exhaust Lines

By E. J. Tangerman

Out at Nordberg, I saw a big 2250-hp. diesel for Ponca City, Okla., on test. Quite an impressive sight, with one of the test crew on the platform indicating a 21 x 29-in. cylinder. And on the exhaust manifold, some wag had stenciled "Laddie Boy."

When National Aluminate built its windowless office building, someone remembered that there's nothing blacker than the inside of a windowless building when the lights go out. So at the end of each side corridor is a glass door leading to the inside fire escape, and each escape well is pierced by a bullseye window. If lights fail during the day, the bullseyes let in at least a little light. Seems funny to sit in one of those buildings—no traffic noise, no rain or snow to watch—just walls. Helps one keep at work, but foils a lot of amateur weather watchers.

After a 10-year layoff, I tried driving a tractor again late in June. But this time it wasn't one of the old 5-ton Holts; it was a new "Cat" diesel. No more grabbing frantically at the steering-arm quadrant to give 'er more gas when you turn a corner—the new ones have a floor lever set to a certain speed, then a governor provides more fuel when necessary to maintain that speed.

Caterpillar also is just completing a diesel emergency set, designed for hospitals and plants where continuous current is vital. On power failure, a series of Cutler-Hammer controls ties in a battery-driven starter. Engine starts I timed took 2 sec., then 3 sec. more before the engine was up to speed and the generator taking over the load. This 100-kw. set is silenced with a Burgess hood, and the usual radiator is replaced (because of the hood) by a jacket-water circulating system tied in with a Binks cooling tower right alongside.

THE ENGINEER *(London) recently illustrated some new miniature ball bearings, planned to replace plain bearings in small motors, electric clocks, meters, and pressure gages. Sizes range from* 1½ *to* 10 *mm., or* 0.06 *to* ¼ *in. over-all.*

100,000 lb. of boilers went by air to Berens River Mines, Canada, during the past winter. They were putting in a gold mine, and needed two wood-burning boilers to operate at 145 lb., but how to get them across the inaccessible wastes? From Foster Wheeler's boiler shop at St. Catherines, Ont., parts went to Winnipeg by rail, then by steamer 200 miles to the Berens River in summer, or on sleds pulled by tractor in winter, and finally 145 miles farther by plane. No single piece could weigh more than 2,000 lb. or be over 10 ft. long, and plane doors were small. Boilers were 3-drum low-head units, with drums just too darn long to go into the plane, so they protruded on one side, and streamlining had to be built over the ends. To avoid the weight of conventional brick boiler settings, a special plastic-refractory-and-insulation arrangement, housed in a steel casing, was developed. The stack, 42 in. in diameter and 50 ft. long, was shipped as curved plates 5 ft. 8 in. long by 6 ft. 6 in. wide and assembled on the job.

DuPont had so much trouble with thieving of light bulbs that plant engineers ordered all of them etched "Stolen from duPont." That ended the thieving, but Christ Church, Roanoke, Va., complained of the same thing. One of the vestrymen, a duPont employee, suggested the answer.

Keep on your toes and you won't be down at the heels.

Ultra-Modern Hookups for Byproduct Power

This article, based on information supplied by engineers of Sulzer Bros., Winterthur, Switzerland, will be published in two sections. Starting with well known combinations and principles, it develops power-process steam combinations practically unknown on this side of the Atlantic

EVEN today there are industrials which waste 85% of the coal's heat in flue gas and cooling water, yet generate process and heating steam in special low-pressure boilers. The excuse is "simplicity." Most engineers recognize the fact that there are bigger savings to be made by utilizing this waste heat than by attempting to improve the efficiency of prime movers, already approaching practical limits.

Any existing low-pressure plant can be effectively changed into a high-pressure plant by adding high-pressure steam boilers, back-pressure prime movers and a steam transformer (an evaporator connected to receive the exhaust of high-pressure units and produce steam at a lower pressure). Investment is moderate and the steam transformer keeps the high-pressure and low-pressure circuits completely independent, so that no changes need be made in the low-pressure system. The low-pressure boiler can be retained as a standby for peak loads.

For a back-pressure plant, increased pressure, within certain limits, means increased over-all efficiency. But turbine efficiencies fall off at high pressures, so it rarely pays to use an initial pressure above 1800 lb. The limit depends, of course, on the size of turbine and class of service.

The usual design starting point is a certain desired quantity of process and heating steam at a given back pressure. With given assumptions, curves are available showing how much power can be generated with a given flow of steam with any initial pressure. [Curves supplied for this by the authors are omitted because similar curves have been published before.—*Editor*]

Heat Ventilation by Stages

As a starting point, let's take the simplest and least economical combination: a steam power plant generating electricity only, a process-steam generator, and a boiler supplying heating steam. This combination may be replaced by a combined high-pressure primary power plant exhausting to a steam transformer supplying process and heating. The change from parallel flow to series flow saves much fuel.

Figs. 1 and 2 compare these two hookups on an energy basis. In both examples power output corresponds to 10 energy units, process steam to 40 units and heating steam to 26 units. A boiler efficiency of 80% is assumed for the process-steam generator and of 75% for the heating boiler. Then the parallel-flow system requires 50% more fuel than the series system, for the same output.

Sacrifices Independence

True, the series system sacrifices, to some extent, the independence of the various services. It will not often happen that steam delivered by the high-pressure stage will exactly meet the requirements of the low-pressure stages. The working of the high-pressure, low-pressure and heating plant will be mutually dependent. This requires automatic regulation of the entire system. However, it is generally easy to apply suitable regulation because the heat inertia of the connected plant is comparatively great. If the lower stage momentarily requires more steam than is exhausted from an upper, the difference is supplied direct from the boiler through a reducing valve. If, on the other hand, the prime mover is carrying a peak load when process and heating requirements are small, superfluous exhaust steam can go to a condenser or a heat accumulator.

Since the combinations that may occur are almost infinite, extreme flexibility is a basic requirement of such a plant.

From one angle, but not from all, a normal high-pressure water-tube boiler is quite suitable for the primary high-pressure stage. Its advantage is the flywheel effect of a large quantity of water stored in its drum. On the other hand, with sudden load fluctuations of 50% or more, it may be impossible, with a water-tube boiler, to keep superheat temperatures constant within the limits required for the high-pressure steam turbine. To meet this condition one needs a boiler in which superheat temperature is controlled by a precision governor with the least possible inertia.

One type of boiler particularly suited to this type of combined service is built with exclusively tubular heating surfaces and small water spaces. Superheat temperature is mechanically regulated. First cost is lower than with any type of high-pressure boiler with large water spaces. The automatic regulation of these new steam generators—and this is their special advantage—does more than regulate the boiler itself; it also regulates the high-pressure prime movers served. Thus regulation of the whole plant is made more simple and can be handled from one central position.

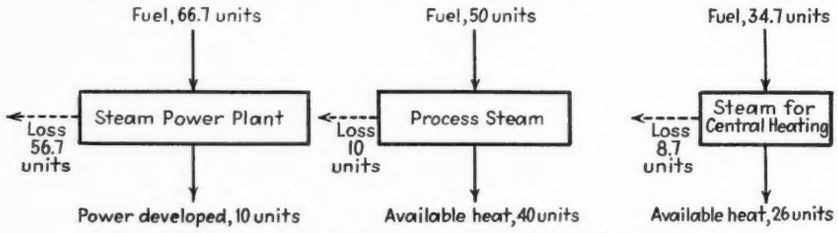


Fig. 1—Plants working in parallel. Heat balance: fuel, 151.4 units; available heat, 76 units; losses, 75.4 units; efficiency, 50%

Handling Peak Loads

If fluctuations are heavy and rapid, or if peaks of power and heating steam occur at very different times, large water spaces may be desirable as a standby. But water storage in high-pressure boilers is very costly. Therefore, if heat storage is to be taken care of in the boiler itself, moderate steam pressure is necessary. This mod-

erate steam pressure, in turn, must sacrifice much of the advantages of double-steam use.

On the other hand, it makes little difference how high the pressure of the standby is, as long as it contains enough energy; so low-pressure water storage is here the most economical solution. Fig. 3 shows a high-pressure plant with low-pressure storage. Any fluctuation in the electrical load of generator *G* or steam-heating load *H* is taken care of primarily by the large water space *NS*. All the firing has to do is to follow the demand of process-steam plant *F*. Sometimes a sudden and unexpected increase in process-steam demand will occur. Then the

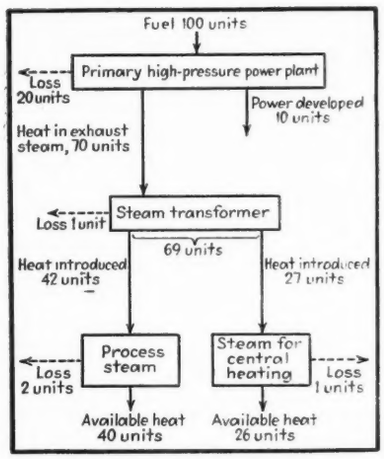


Fig. 2—Plants working in series. Heat balance: fuel, 100 units; available heat, 76 units; losses 24 units; efficiency, 76%

line supplying steam to the medium pressure turbine *MT* is automatically closed by the valve *RV* to maintain pressure in the process-steam line at 170 lb. or slightly below. At such times all steam generated can be delivered to process. To a large degree this arrangement has all the thermal advantages of the high-pressure cycle. It is particularly useful with coal firing.

Combined Service in District Heating

In district-heating plants it is customary (in Europe) to obtain as much mechanical power as possible from heating steam. This is best accomplished when the electrical side of the district-steam plant is tied to the central-station system.

A district-heating plant of this type, which has been in regular service for some years, includes a 1,400-lb. Sulzer single-tube steam generator and a 500-lb. Sulzer water-tube boiler. Each has a normal capacity of 40,000 lb. of steam per hr. and a peak-load capacity of 45,000 lb. In addition, this system includes two 155-lb. electric boilers, each capable of evaporating 5,500 lb. of water per hr. The electric boilers are generally worked during the night with surplus electric energy and are used chiefly in the spring and autumn.

This plant is shown diagrammatically in Fig. 4. The single-tube steam generator *EK* consists essentially of two lengths of tube arranged in parallel, each 4,000 ft. long. They lead separately from economizer inlets to superheater outlets, except for a common separator at the end of the evaporating zone. The boiler has a traveling-grate stoker, a battery of oil burners and all necessary regulating and safety devices. Steam, at 1,400 lb. and 840 F, is first expanded to 500 lb. in the back pressure turbine *HT*. Turbine exhaust is pooled with the steam output of the 500-lb. water-tube boiler.

Steam at 155 lb. and 30 lb. is needed for the heating system. The extraction back-pressure turbine *AT* expands 500-lb. steam to 155-lb. bleed and 30-lb. back pressure. On the other hand, condensing turbine *KT* expands the 500-lb. steam to bleed pressures of 155 lb. and 15 lb. as well as to condenser pressure. Obviously, the most rational form of service is given when all steam produced by the 1,400-lb. boiler is reduced through the back-pressure turbine. However, because of the special character of the plant, arrangements are made for independent operation (if desired) of the 1,400-lb. and 155-lb. boilers.

If necessary, steam raised in the Sulzer boilers may pass directly to the district-heating system without going to the steam turbine. In the steam distributing and reducing station, which is fitted with a number of oil-operated pressure regulators, steam pressures of 1,400 lb., 500 lb. and 155 lb. are kept practically constant. Boilers, turbines and central heating here form a single unit, regulated from a central position.

From the point of view of national economy, district-heating stations generating byproduct power are at present the most favorable solution. Use of large boilers gives good combustion of fuel and high efficiency. It is practical to generate heat at high temperature and pressure, permitting power recovery in substantial quantities.

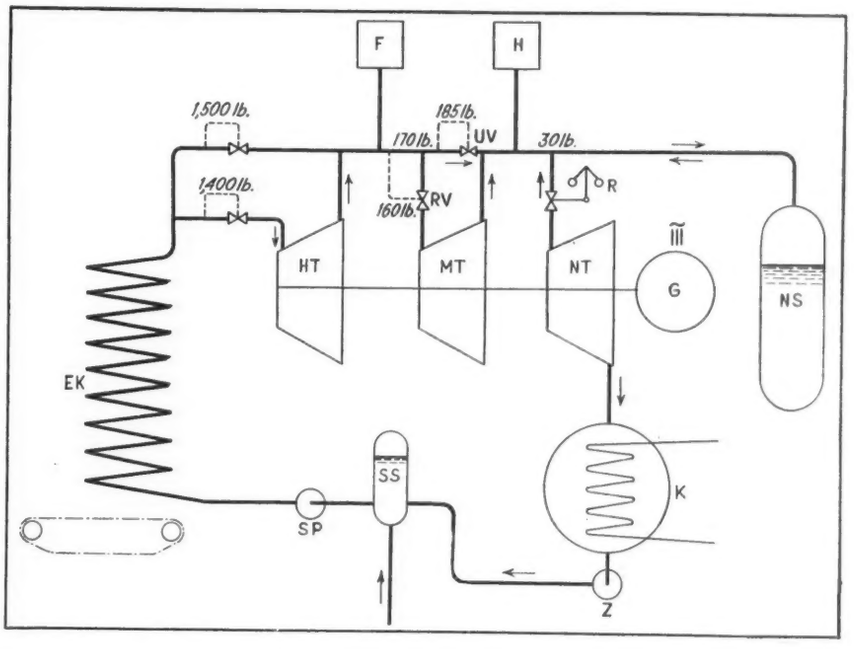
Plant Primarily for Heating Steam

The district-heating plant just described was put in as a new plant. An entirely different problem is represented by the conversion of an existing low-pressure plant by adding a Sulzer high-pressure primary steam plant with a single-tube boiler. The plant described here has been in regular service for some time. Formerly, process and heating steam was generated at 120 lb. in several fire-tube boilers while electricity for the factory was taken from public mains.

Since installation of the new high-

Fig. 3—Installation with high-pressure primary power plant and low-pressure steam accumulator

EK Sulzer single-tube boiler
HT High-pressure turbine
MT Medium-pressure turbine
NT Low-pressure turbine
G Electric generator
K Condenser
Z Condensate pump
SS Feedwater tank
SP Feed pump
NS Water accumulator
R Speed governor
RV Regulating valve
UV Bypass valve
F Plant utilising process steam
H Central heating



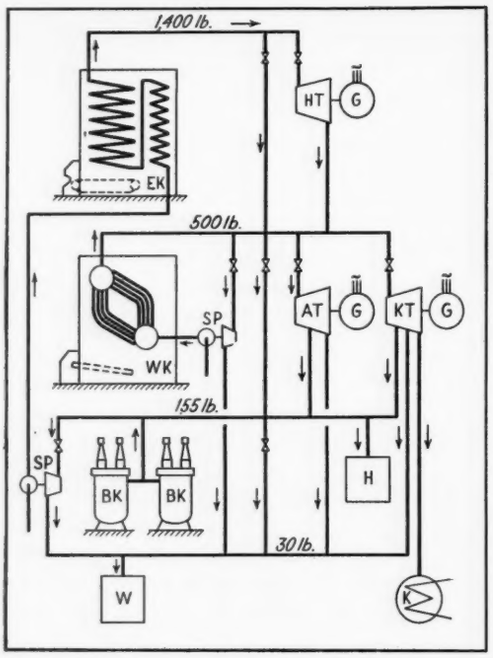


Fig. 4—District-heating installation with high-pressure primary power plant

WK	Water-tube boiler	KT	Condensing, bleeder turbine
EK	Sulzer single-tube boiler	G	Electric generator
HT	High-pressure turbine	K	Condenser
AT	Back-pressure, bleeder turbine	SP	Feed pump
		BK	Electric boilers
		H	Central heating
		W	Hot-water supply

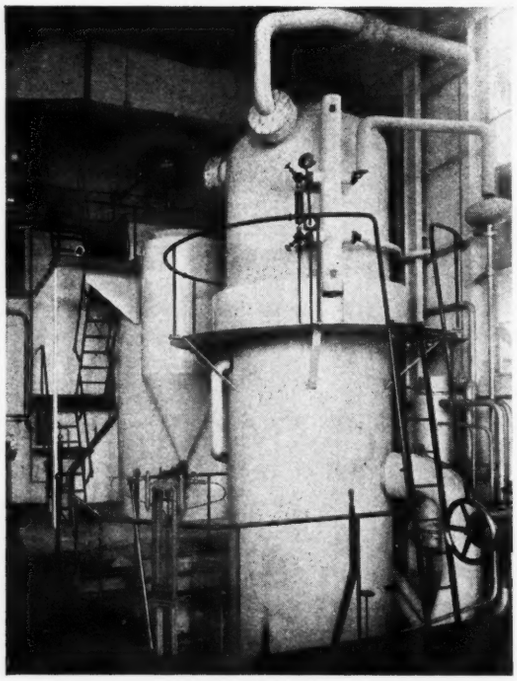


Fig. 5—Steam transformer fitted between a high-pressure primary power plant with a pressure drop from 1,400 to 140 lb. abs., and a low-pressure plant working at 115 lb. initial pressure

pressure steam plant most of the electrical demand is obtained as a by-product from the high-pressure prime mover. Steam for process and heating is produced by the evaporator or steam transformer, Fig. 5, into which the high-pressure prime mover exhausts. Existing low-pressure boilers supply any additional steam that may be required at peak loads. The converted plant required about the same quantity of fuel as the original plant. Ratio of steam to electrical demand is high in this plant, so that the turbine, particularly in winter, can develop more mechanical energy than the factory requires. The surplus is delivered to the municipal central station, which operates in parallel, and, at times of low steam load, supplies electricity to the factory.

The high-pressure steam plant shown diagrammatically in Fig. 6 consists essentially of the single-tube generator *EK*, together with low-pressure economizer *E*, high-pressure steam turbine *GT* with generator *G* and steam transformer *DT* with the feed pump *DP*. Pump *KP* feeds low-pressure boiler *K* and triplex pump *P* feeds the high-pressure single-tube generator.

The single-tube generator, equipped with an underfeed stoker, has a capacity of 14,000 to 18,000 lb. of steam per hr. at pressures ranging from 1,400 to 1,600 lb. and at temperatures from 750 to 850 F. Steam raised passes through a 15,000-r.p.m., 750-hp. turbine with two pressure stages. Through a reduction gear this drives a 500-kw., 3,000-r.p.m. generator. This primary turbine reduces steam pressure from about 1,500 to 130 or 140 lb. After the generator has been paralleled, speed governor is brought into its lowest position; it then acts as a safety governor. Should maximum speed be exceeded, a quick cutout device, independent of the governor, shuts off steam supply to the turbine.

The primary high-pressure system works with pure condensate from the transformer. Exhaust steam from the turbine passes to the steam transformer and is there condensed. Condensate is pumped through triplex pump *P* from tank *S* to the high-pressure steam generator. A quantity of water, normally equal to the primary condensate, is taken from the feedwater tank of the low-pressure plant and pumped by *DP* through an economizer and the water-level regulator *W* into the steam transformer, where it is evaporated by high-pressure exhaust. Steam so produced is delivered to the heating-steam main which was formerly supplied by the low-pressure boiler.

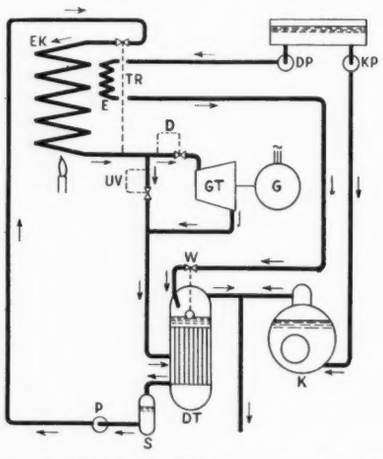


Fig. 6—Combined high-pressure and back-pressure plant, where demand for heating steam is predominant

EK	Sulzer single-tube boiler	K	Low-pressure boiler
E	Low-pressure economizer	P	Feed pump to high-pressure boiler
GT	High-pressure turbine	S	Condensate tank
G	Electric generator	W	Water-level regulator
DT	Steam transformer	UV	Bypass valve
DP	Feed pump to transformer	TR	Temperature regulator
KP	Feed pump to low-pressure boiler	D	Pressure regulator

Automatic Regulation

All regulating equipment in the primary and secondary system is operated with oil under pressure. An important feature is temperature regulator *TR* which keeps final steam temperature constant by injecting a small quantity of feedwater at the superheater entrance. Water delivery from the triplex feed pump is regulated by leading surplus pumpage back to the suction side. Boiler pressure is kept constant by pressure regulator *D* and overflow valve *UV*. The valve operated by the pressure regulator *D* determines flow of steam into the high-pressure turbine. If the quantity of steam produced is greater than the turbine requires, pressure in steam piping ahead of *D* can rise from 1,400 to 1,500 lb. Thereafter overflow valve *UV* bypasses steam directly to the steam transformer.

[*The concluding section of this article will describe a very unusual and ingenious hookup of a plant revamped, with an added high-pressure boiler and other equipment, to produce a maximum power output with least possible consumption of fuel.—Editor*]

PRACTICAL AIDS TO OPERATION

Welds Stainless-Steel Seals to 48-in. Check-Valve Disks

Six years ago, Wilmette, Ill., installed a storm-water pumping system consisting of drain pipes leading to a pumping plant equipped with two 350-hp. diesel-driven and one 75-hp. motor-driven single-stage centrifugal pumps. These pumps, with a total capacity of 160,000,000 g.p.d., are located above water level; therefore require priming before starting. To do this it is necessary to have vacuum-tight check valves on the ends of the 48-in. discharge pipes which are about 100 ft. long. A disk from one of the valves is shown, and has a 1 in. wide face that bears against the machined and rubber-faced seat on the discharge-pipe end. This disk is fabricated from standard plate steel and angles, electrically welded and then machined on the face.

After several years of service these valves commenced to leak and grew steadily worse until it was nearly impossible to prime the pumps. It was found that their machined faces had accumulated a hard-rust coating up to $\frac{1}{16}$ in. thick. Disks were also warped, probably because stresses imposed by original welding had slowly released themselves over a period of years.

To correct both corrosion and warping, $\frac{5}{16}$ in. was machined off disk faces, and a ring of 18-8 stainless steel $\frac{1}{2}$ in. thick was formed and electric welded all around, inside and out, to the remaining old faces. Then, disks were subjected to a stress-relieving heat treatment by putting them into a cold furnace, bringing temperature up to about 1,000 F, soaking at this temperature for about 3 hr., and then cooling them in the air. After this, disks were put on the boring mill and the stainless-steel faces machined true.

However, a great shock was in store for us, for after installing one of these newly machined valve disks, we found it leaked worse than ever. The lower half of the disk face did not seat against the pipe, and at the bottom of the pipe the opening was 0.135 in. To prove where the trouble was, we put the disk back on the boring mill and found it was true to within 0.008 in., which showed the cast-iron pipe was at fault. A tapered lead shim was made and installed under the rubber gasket. Now, these valves hold an 18-in. vacuum with practically no leakage.

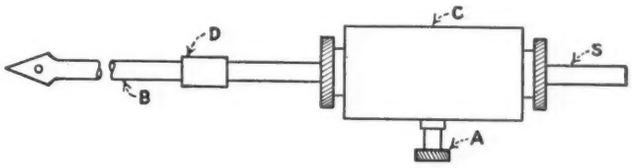
Kenilworth, Ill. — Roy Pavlik

Tool for Cleaning Surface Condensers

Inability to maintain a vacuum on our steam turbines made it advisable to remove a condenser head to examine condition of the tubes. We had been using river water for circulation in the condensers and were surprised to find nearly all the tubes stopped with a mud formation baked to the hardness of brick mortar. The tool shown in the figure was built to do the cleaning job.

C is a hollow cylinder with connection *A* for attaching a 1.5-in. hose. Shaft *S* passes through a packing box at each end of the cylinder and terminates in a threaded coupling *D*. The shaft is hollow back into the cylinder where ports are provided to admit water. Bit *B*, made of a piece of $\frac{1}{8}$-in., extra-heavy pipe, completes the tool.

At the cutting end, the pipe is flattened to form a



spear head, which will go inside the $\frac{5}{8}$-in. condenser tubes. Holes drilled in the head allow water to flow and wash out the material loosened by the tool. At its right-hand end tool *B* threads into coupling *D*. When used, water under pressure is connected to the cylinder at *A* and flows into the hollow shaft and out the cutting end which is rotated by an electric drill attached to the right-hand end of the shaft. This tool was used to clean an 1,800-sq.ft. and a 2,000-sq.ft. condenser without damage to a single tube.

Grenada, Miss. — E. R. Hallam

Installing Welded Boiler Tubes

Renewal of a tube in the lower rows of a water-tube boiler is a more or less common occurrence in plant maintenance. Cutting out old tubes and expanding and flaring new ones are usually well understood, and little difficulty is experienced with tube replacements. Without entering into a discussion of the merits and

demerits of seamless and welded boiler tubes, it is sufficient to say that properly welded tubes are permitted by the A.S.M.E. Power Boiler Code.

Use of welded boiler tubes brings up a point in installation that is often neglected—location of the weld with respect to the combustion chamber. The weld should not be exposed to radiant heat of the fire, which in most boilers requires that the welded seam be at the top.

Formation of scale in the tube often causes high temperatures in the tube wall. Slight distortion and bulging may occur in the tube section exposed to the fire. If this occurs in a weld at high temperatures, failure of the weld is threatened. Slight distortion in a seamless section is not desirable, but is usually not serious if it does not increase.

Cleveland, O. CHARLES A. ARMSTRONG

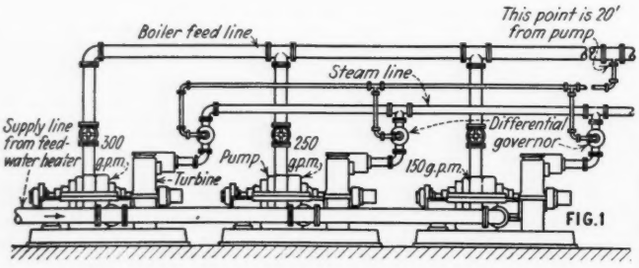


FIG. 1

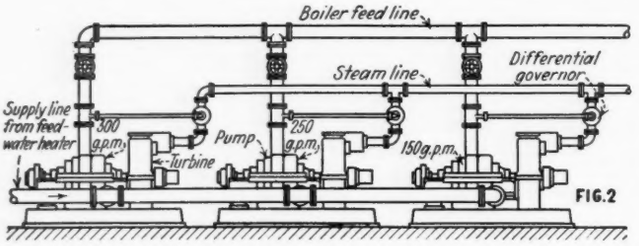


FIG. 2

Pump-Governor Connections for Parallel Operation

WHEN power-plant capacity is increased, each boiler-feed pump will often have greater capacity than its predecessor. For instance, in one plant the original boiler-feed pump had a capacity of 150 g.p.m. against a 525-ft. dynamic head. Later a second 250-g.p.m. pump was installed followed by a 300-g.p.m. unit, all for the same head. When the third pump was installed, plant load required about 140,000 lb. of steam per hr. Water for this amount of steam is 65,000 lb. per hr. in excess of the capacity of the first pump and 10,000 lb. below that of the largest. Obviously if the 300-g.p.m. pump fails, both smaller pumps must be operated in parallel.

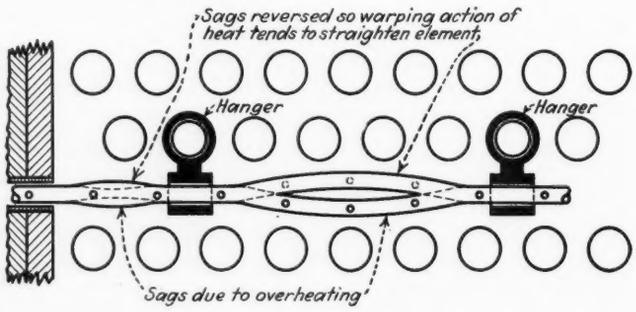
To obtain parallel operation, differential pressure governors were installed on each pump, but unsatisfactory operation made it necessary to use manual control. The source of trouble was indicated by the recording pressure gage on the pump discharge header, which showed pressures of 215 to 275 lb. This was caused by taking the hydraulic pressure connection for the governors, from the discharge of the pumps, Fig. 1.

To correct this difficulty, the hydraulic pressure line for the differential governors was changed from the header to the pump discharges, about 2 ft. away from the pumps, Fig. 2. This gave sufficient pipeline drop between the pumps to permit accurate control. Any change in feedwater-header pressure causes the governors to regulate simultaneously speed of the pumps by adjusting the steam flow to their turbines.

Philadelphia, Pa. H. C. CHARLES

Preventing Binding of Soot-Blower Elements

SOOT-BLOWER elements, when overheated, often sag between their bearings and either break or become difficult to operate. This trouble occurs most frequently with first-pass elements exposed to high gas temperatures or direct radiant heat of the furnace.



Sagging and its attendant troubles can be minimized in several ways, such as: using elements made of special alloys that retain their mechanical strength even though subjected to intense heat; avoiding long unsupported lengths by increasing number of bearings; and, where soot-blowing efficiency is not appreciably affected, relocating elements in zones of cooler temperature.

When, in spite of all these precautions, elements do warp and become hard to operate, it is often possible to alleviate the condition by occasionally reversing the sag during periods when the soot-blower is idle. If this is done, any further action of heat will tend to straighten the element rather than increase the warp. When performing this operation, the element should be turned 180 deg., as in the figure, after the main soot-blower steam valve is closed, and restored to its normal position before this valve is reopened.

Roanoke, Va. S. H. COLEMAN

Flowmeter Measures Small Flow Accurately

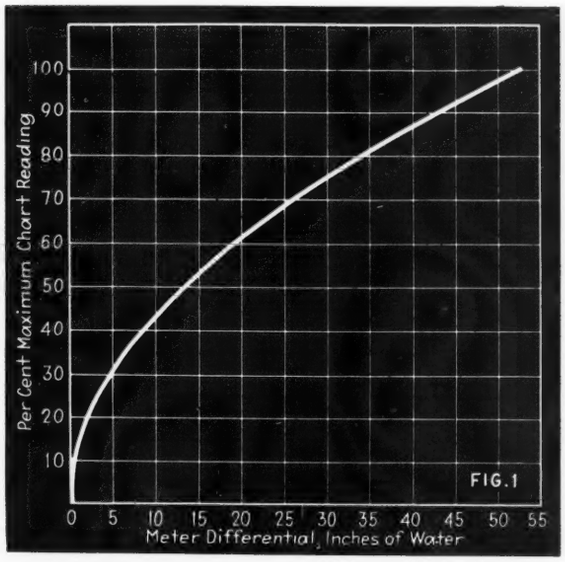
FLOWMETERS are not as a rule accurate when metering quantities less than 20% of their maximum chart range. This inaccuracy may result singly or cumulatively from a number of causes, among which are errors introduced by the orifice, improper installation of the meter or piping, air in the lines, and dirt, air, or friction in the meter itself.

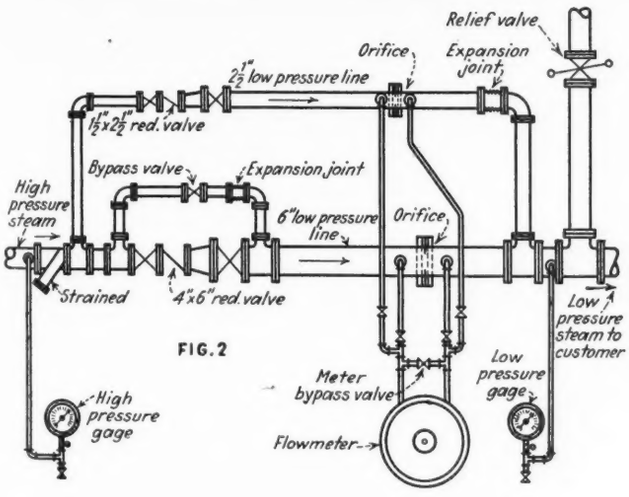
As it is almost impossible in the average installation to eliminate all of these factors, a slight error is usually present in the differential head acting upon

the meter. While effect of this error in the higher chart ranges is negligible, meter readings in the lower ranges are often seriously affected.

This seeming discrepancy may be better understood if it is remembered that the square root of the differential pressure across a given orifice or flow nozzle varies directly with the flow of fluid at constant density passing through the line. The meter measures this differential, extracts its square root, and expresses the result in the quantity units desired.

By referring to the typical flowmeter calibration curve, Fig. 1, it is easy to visualize this relation and the effect of a false increase or decrease of only a few tenths of an inch of water in the differential head. Because of the steepness of the curve in the lower ranges, a high per cent of error would be introduced, while at the higher ranges the curve flattens out and





the per cent error would come well within the accuracy expected of the average flowmeter.

In a recent metering installation on the low-pressure side of a reducing valve, the possibility of large error with small flows was minimized by installing two orifices. As shown in Fig. 2, a large and a small reducing valve are used to eliminate chattering that might occur with one large valve at light loads. The orifice in the smaller line is designed so that when connected to the meter, full-scale reading is exactly 33⅓% of flow indicated with the larger orifice in the large steam line.

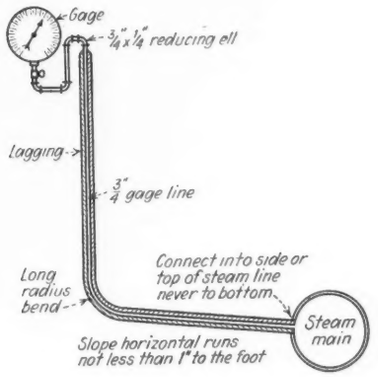
When the flow through the large reducing valve drops below 25% of the meter-chart reading, this valve is cut out and the small reducing valve placed in service. Flowmeter connections are likewise changed to the small orifice and a new chart and integrator factor applied to the readings. With an increase in flow that approaches the full scale reading with the smaller orifice, this procedure is reversed and the meter is connected to the large orifice.

Chicago, Ill. R. C. HENDERSON

Steam-Gage Piping Placed Above Steam Lines

VARIATIONS of static head of water in piping may affect accuracy of steam gages and other pressure-responsive equipment such as reducing valves and similar devices. This inaccuracy is frequently found where gages are installed at an elevation greater than that of the steam main, and with piping either too small or trapped so as to contain water.

With pressure on the main at all times, presence of water in the gage line can be tolerated. Static head


Gage
¾"x¼" reducing ell
Lagging
¾" gage line
Connect into side or top of steam line never to bottom
Long radius bend
Steam main
Slope horizontal runs not less than 1" to the foot

remains constant, and can be compensated for by applying a correction factor to the gage equal to 0.434 lb. for each foot of vertical rise containing water. This factor is added to the gage reading when the gage is above the main, and subtracted when the gage is below the pipe.

When a steam main is frequently removed from service, a variable static head often exists in the piping of gages located above the lines, if this piping contains water. With pressure off the main, water tends to drain out, decreasing static head. When pressure is restored, some time must elapse before enough steam condenses to fill the line and restore normal head. Air often gets into the gage piping, causing a variation in the effective static head.

These fluctuations can be avoided by installing large-diameter, properly-drained and well insulated gage lines, as in the figure. As no water can accumulate in the vertical rise, static-head conditions do not exist. It is well to remember, however, that a gooseneck must be provided at the gage to protect the bourdon tube from direct contact with live steam.

St. Louis, Mo. O. C. MILES

CURRENT COMMENT

Balancing-Drum Clearance Should Be Checked

SUPPLEMENTING the answers to the question on feed-pump vibration, July *Power*, I would like to add that, because the pump performed faultlessly when first installed, the vibration that developed is probably caused by incorrect pump reassembly. The trouble will probably be found in balancing-drum adjustment. Reference should be made to the manufacturer's recommended clearance for this adjustment. Then, with this figure in mind, proper allowance can be made for water temperature in excess of that for which the pump was designed to operate. The balancing-drum is intended to keep the rotor centrally located and compensate for end thrust. Thrust bearing should carry little or no load and perform only in emergencies.

If balancing-drum clearance is insufficient, metal to metal rubbing might occur, and failure of drum would follow. On the other hand, if this clearance is too great, excessive water pressure would exist at the packing glands and make it necessary to operate with too much packing pressure. This would account for worn packing sleeves.

Vibration of the pump that operated satisfactorily for 3 years was probably caused by scale accumulation on the balancing device. This reduced clearance and caused the drum to rub or to overload the thrust bearing.

Too much care cannot be exercised in getting drum clearance correct. As it is, probably between 0.010 to 0.012-in. feeler gages should be used. If balancing-drum clearance is adjusted so that little or no load is put on thrust bearing no further trouble should be experienced.

Scottsbluff, Neb. C. A. VAN DEURSEN
The Western Public Service Co.

Keeping Compressed-Air Systems Clean

RECENT numbers of *Power* have contained articles stressing operating and maintenance schedules for compressed-air systems. Dangers of oil deposits have been explained, and valuable operating pointers for preventing these accumulations described. However, consider a compressed-air system that is already badly fouled by oil deposits. Internal surfaces of air receivers, compressor-discharge piping, and aftercooler may be heavily coated with such deposits. Frequently, entrance to the air receiver is impossible, and dismantling of the entire piping system for cleaning constitutes such a considerable expense that other means for cleaning must be found.

One method, practiced in many plants, consists of feeding a soapy solution through the system. A time is selected when there is no demand for clean air. A pound of soap powder is stirred into a pail of hot water and is mixed to heavy suds. The air-receiver blowdown is opened and piped to waste, the compressor operated, and the soap suds fed slowly into its intake. Oil and sludge deposits will be blown from the system as they are loosened by the soap suds. Treatment is repeated until clean air discharges from the blowdown.

A compressed-air system about 15 years old, that has been given an internal washing every 6 months, was dismantled recently and examined. Internal surfaces of piping and receiver were free from practically all deposits. Minimum amounts of high-grade oil for compressor-cylinder lubrication contributed much to the good condition. Proper cleaning and lubricating maintained the compressor in excellent condition for over 100,000 operating hours.

Cleveland, O. A. C. WIGGINS

Coal Sticking in Silo

AS AN addition to the questions on coal sticking in a silo, June *Power*, I am prompted to say that the matter of discharge efficiency with coal- and ash-storage units is still greatly neglected, even though accidents to trimmers and spontaneous combustion in idle coal between outlets or gates are frequent enough. Until storage capacity is considered jointly with discharge efficiency, coal and ash handling tend to remain the step-child of the otherwise efficiently designed and operated power plant.

A concrete silo of about 80 ft. in height, and, presumably, having a flat bottom of about 20 ft. in diameter, will permit moist coal to compact under sufficient pressure and to adhere to the usually rough interior finish of the silo.

If at least the bottom portion of the silo could be cleared sufficiently, coal in the upper portions, having lost its vertical support, is bound to break down either its condition of arching or its adherence to the rough inner surface of the silo. Thus, shaping of the bottom portion in a discharge-efficient hopper is the first requirement. This shape depends on whether outlets are located in the silo bottom or side. If the former, there should be a ruggedly constructed agitator above the gate to break down inevitable arching and prevent formation of a "bottle neck." If the outlet is on the side, the agitator is of less importance, as components acting on the outlet are more favorable to free discharge.

Access doors should be located at many different levels in a tall silo so that trimmers should not have to enter a silo under any conditions. With a view to possible freezing, there should be an efficient thawing out arrangement near outlets to clear out "bottle necks" before upper strata have a chance to break down under their own weight.

New York, N. Y. EUGENE HAHN

More About Globe Valves

A TIMELY article on installation of globe valves which appeared in Practical Aids, June *Power*, deals with a subject that deserves more attention. Globe valves on feed lines of stationary boilers, under the A.S.M.E. Code, should be installed so that water pressure comes under their disks in order that water may be fed to the boiler at all times, even if the disk should drop. This also prevents packing the valve while the boiler is under pressure, which keeps workmen from getting scalded.

Globe valves are not permitted on blowoff lines of high-pressure boilers operating in Code States. An angle valve is required to have boiler pressure on top of the disk to prevent loss of water in the event the disk drop. When valves are used in water-column connections on boilers operating at more than 15 lb. pressure, they must be outside screw-and-yoke-gate type, and they should be locked or sealed open.

In railroad work, globe valves are installed on feed lines with pressure on top of their disks, this being done so that the valve may be packed under pressure. This practice prevents shutdown of an engine on the road and warping of the disk, which occurs when a valve is installed with water pressure under the disk. Considerable trouble is encountered from leakage and disk warpage when valves, angle or globe, are installed in accordance with Code requirements, but safety first is the paramount issue.

Globe or angle valves in steam lines should be installed to avoid water pockets. In the case of an angle valve, install it when possible with handle wheel upright and boiler pressure under the disk.

For automatic stop and check service, boiler pressure should come under the disk. The valve can then be closed by a hand wheel, but can be opened only by boiler pressure. This provides for safety under all operating conditions.

Buffalo, N. Y. JOHN J. TIMMONS

Causes of Vibration In Boiler-Feed Pumps

IN THE May number of *Power* I read the answers to the question on causes of vibration in centrifugal-type boiler-feed pumps. It is my belief that the following factors are at fault: temperature changes in feedwater cause flashing in the pump; suction or discharge lines held too rigidly cause pipe-expansion stresses to throw the pump casing out of line with the rotor shaft; insufficient play in the flexible coupling between pump and driving unit doesn't compensate for a reasonable amount of misalignment; the foundation may have settled; or the bedplate may be warped. Remedy for these conditions is obvious.

Cleveland, O. F. R. RYBERG

MANUFACTURER'S BULLETINS

Motor Base—American Pulley Co., 4200 Wissahickon Ave., Philadelphia, Pa. 12-page catalog illustrates cradled motor base said to automatically control belt tension and match it to changing conditions of load.

Lubrication—Shell Petroleum Corp., St. Louis, Mo. First three booklets of a series, "Panorama of Lubrication", explain fundamentals of lubrication, lubricating friction-type bearings, and process of making Golden Shell motor oil. Very well illustrated and informative booklets.

Condenser Tubes—Scovill Mfg. Co., Waterbury, Conn. A handsome picture story of condenser-tube manufacture, plus sections on composition and physical properties of Scovill tube alloys, specifications, and installation methods and tools. Excellent photographs.

Flowmeters—Brown Instrument Co., Philadelphia, Pa. Catalog 2004 covers indicating, recording and integrating meters, in both electrical and mechanical types. Explains applications to power plants, water works and gas-generating stations, as well as to general industrial use. Well illustrated, 56 pages.

Diesel Power Units—Fairbanks Morse & Co., 900 S. Wabash Ave., Chicago, Ill. Bulletin 3600-A1 describes construction and application of Model 36 engine for stationary, completely-enclosed power unit or for portable or semi-mobile unit. Two cylinder sizes, 4¼x6-in. for 1,200 r.p.m. and 5½x7½-in. for 900 to 1,200 r.p.m. 1-, 2-, 3-, 4- and 6-cyl. units in smaller cylinder size; 4-, 6- and 8-cyl. units in larger size.

Proportioning Equipment—D. W. Haering & Co., Inc., 3408 W. Monroe St., Chicago, Ill. 24-page illustrated catalog "The Art of Proportioning" explains use of fluid-piston principle and describes Model **B** and Model **B** Junior proportioning feeders. Construction, operation and application shown with installation photographs.

Thermometers and Hydrometers—C. J. Tagliabue Co., Park & Nostrand Aves., Brooklyn, N. Y. 16-page Catalog 1100A describes complete line of TAG thermometers and hydrometers. Comparison scale graduations, corrections for emergent stems, instructions for use, and conversion tables. Illustrated.

Electric Motors—Allis-Chalmer Mfg. Co., Milwaukee, Wis. 4-page leaflet No. 2241 describes and illustrates "Quick-Clean" motors for cotton mills or similar usage where protection against lint accumulation is desired. 5-, 7½-, 10- and 15-hp. sizes.

Firebrick—A. P. Green Fire Brick Co., Mexico, Mo. 16-page illustrated bulletin describes manufacturing process of "Empire" firebrick.

Fluid Meters—Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, Ohio. 40-page Bulletin 301, "Bailey Fluid Meters for Steam, Liquids, Gas", illustrates method of combining indicating, recording and integrating features with a flow mechanism for measurement under high, low or medium pressure. Also describes wide variety of primary elements and installation considerations.

Stokers—Detroit Stoker Co., General Motors Bldg., Detroit, Mich. 24-page illustrated catalog shows typical installations in schools, colleges, and other educational institutions.

Bent-Tube Boilers—Combustion Engineering Co., 200 Madison Ave., New York, N. Y. 34-page illustrated catalog shows cross sections of typical installations, photographs of furnace and boiler details, and shop views showing fabrication of high-pressure, fusion-welded drums.

Hydraulic Turbines—S. Morgan Smith Co., York, Pa. "Power by Smith," 32-page bulletin No. 132, shows various turbines for different applications, and describes Smith, Kaplan and impulse units.

Controller—C. J. Tagliabue Mfg. Co., Park and Nostrand Aves., Brooklyn, N. Y. Catalog 900C. "Tagliabue Non-indicating Temperature and Pressure Controllers," describes and lists latest model controllers. Cross sections, ranges and specifications.

Voltage Regulator—Allis-Chalmers Mfg. Co., Milwaukee, Wis. Bulletin 1170B describes Type AFR automatic-feeder regulators, showing construction and application. Well illustrated, many installation pictures.

Transformers—Allis-Chalmers Mfg. Co., Milwaukee, Wis. 8-page pictorial leaflet No. 2254 describes construction and application of power and regulating transformers.

Air Filters—Air-Maze Corp., 812 Huron Rd., Cleveland, Ohio. 6-page Bulletin NIND-37 on industrial air filters for diesel, semi-diesel, gas and gasoline engines, air compressors, generators, pumping units, blowers and air-conditioning systems. Tables of capacities, dimensions and weights. Also information on how to determine size required.

Circuit Breakers—General Electric Co., Schenectady, N. Y. Mailing leaflet GEA-2603 on Type FK-45 indoor oil-blast circuit breakers designed for 75,000-kva. interrupting rating.

Watthour Meters—General Electric Co., Schenectady, N. Y. 16-page Catalog GEA-2404A describes and illustrates two-element, single-disk meters. Wiring diagrams, ratings and dimensions.

Paints—Skybryte Co., Cleveland, Ohio. 12-page catalog describes applications and characteristics of various industrial paints, including acid- and alkali-resisting paints, aluminum and heat-resisting paints, concrete enamel, and "Rust-tox" (for painting over rust). Application index shows what paint to use on various surfaces under all conditions.

Flexible Metal Tubing—American Metal Hose Branch, American Brass Co., Waterbury, Conn. 16-page Bulletin SS-3 describes construction, typical installations, and applications of seamless flexible metal tubing. Well illustrated.

CO_2 Meters—Brown Instrument Co., Wayne and Roberts Aves., Philadelphia, Pa. Catalog 3005 covers line of Brown indicating

and recording CO_2 meters and combined CO_2 and flue-gas temperature recorders. Schematic diagram illustrates operating principle and describes passage of flue gas through various units. 16-pages, heavily illustrated.

Refractory—Chicago Fire Brick Co., 1467 Elston Ave., Chicago, Ill. Mailing piece on "Super Thermo Stucco", a furnace-wall coating which is said to become an integral part of the original refractory when applied with trowel or spraying mechanism.

Non-Sparking Tools — Beryllium Corp. of Pa., Reading, Pa. Mailing piece on non-sparking tools for reducing fire and explosion hazard.

Ammonia Booster Compressors—Frick Co., Waynesboro, Pa. 12-page Bulletin 516-A on ammonia booster compressors for low-temperature refrigeration. Five sizes, with cylinder range of 5¾ x 4 to 15 x 10 in. Construction diagram and tables of space requirements.

Squirrel-Cage Motors—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Descriptive folder No. 3105 on fan-cooled squirrel-cage motors said to have self-cleaning bearings, tested insulation with taped end turns, and corrosion-resistant construction.

Geared Steam Turbines—De Laval Steam Turbine Co., Trenton, N. J. 4-page reprint from March, 1937 *Marine News* describes new oil tankers "Socony-Vacuum" and "Magnolia", in which De Laval geared turbines were used.

Packing—Metalastic Mfg. Corp., Hackensack, N. J. 16-page illustrated catalog shows types and sizes of coil and formed-ring packings for high-pressure steam valves, refrigerating equipment, swing joints, etc. Also describes bulk packing.

Tanks and Bins—Pittsburgh-Des Moines Steel Co., 3454 Neville Island, Pittsburgh, Pa. Bulletin 502 on elevated steel tanks and bins and general plate fabrication. Illustrated, tables of weights of materials and volume capacities.

Steam Generator—Combustion Engineering Co., 200 Madison Ave., New York, N. Y. 14-page catalog on Type VU 2-drum unit, fired with pulverized coal, oil or gas. Size range of 15,000 to 250,000 lb. of steam per hr. and for any pressure up to 1,000 lb. per sq.in. Illustrated with exterior and cut-away views, line drawings and detailed sectional views.

Centifugal Compressors—Carrier Corp., 850 Frelinghuysen Ave., Newark, N. J. Descriptive folder on centrifugal compressors for air conditioning, cooling, cold storage, ice freezing, etc. Five factors said to produce greater economy and efficiency are presented, with a partial list of users.

Industrial Cleaners—Ideal Commutator Dresser Co., 1221 Park Ave., Sycamore, Ill. 4-page folder describes units for removing dust, metal filings, grindings, abrasives, and dirt from difficult places. May be used as a vacuuming, blowing or spraying unit.

Lead Products—Alpha Metal & Rolling Mills, Inc., 363 Hudson Ave., Brooklyn, N. Y. 15-page catalog on sheet lead, lead pipe, babbitt metals, solders, chromium-plating anodes, etc. Applications and tables of weights and sizes.

Spray Nozzles—Yarnall-Waring Co., Chestnut Hill, Philadelphia, Pa. 4-page Bulletin No. N-615 covers small-size Yarway involute spray nozzles for air-conditioning and general industrial purposes. Capacity charts and tables.

Disk-Brake Motors—Reliance Electric & Engineering Co., Ivanhoe Rd., Cleveland, Ohio. 1-page Bulletin No. 305 on splash-proof, squirrel-cage, disk-brake motors for power applications requiring quick stops or holding of a load. Sectional drawing and rating table.

Monel Gaskets—International Nickel Co., Inc., 67 Wall St., New York, N. Y. 4-page folder on monel gaskets for pressures up to 1,400 lb. per sq.in. and temperatures up to 1,000 F. Types and sizes and partial list of manufacturers.

Capacitors—Cornell-Dubilier Corp., South Plainfield, N. J. Catalog 139A describes pole-type capacitors for power correction of distribution systems, which are said to make possible relief of power system for maximum profitable capacity without adding to present generating and transmission equipment.

Flowmeters—The Bristol Co., Waterbury, Conn. 40-page catalog describes equipment for recording, integrating, controlling, and indicating flow of steam, gas or liquids. Details are given on new electric flowmeter, using Bristol's "Metameter" principle of telemetering, and also on mechanical flowmeters. Reference tables and charts.

Waste-Heat Boiler—Davis Engineering Corp., Elizabeth, N. J. 12-page Bulletin No. 300 shows construction and application of "Paracoil" waste-heat boilers for diesel and gas engines. Tables of size, dimensions and capacities.

Diesel Engines—Venn-Severin Machine Co., 1317 West North Ave., Chicago. 16-page Bulletin 700 shows Type D, Model M engines, 1 to 4 cylinder, 20 to 300 hp. Explains outstanding constructional features and provides detailed description of various parts. Well illustrated.

Motor-Generator Sets—Reliance Electric & Engineering Co., Ivanhoe Rd., Cleveland, Ohio. 4-page Bulletin 501 on motor-generator sets up to 500 kw. Illustrations and construction details.

Pressure Recorders and Controllers—The Bristol Co., Waterbury, Conn. 8-page Bulletin 483 covers new line of low-range pressure and draft recorders and controllers.

Water Systems—Roots-Connersville Blower Corp., Connersville, Ind. 4-page Bulletin 260-B13B describes shallow-well water systems, incorporating Type T turbine pump direct connected to motor with automatic air-volume control.

READERS' PROBLEMS

QUESTIONS for Our Readers

Gasoline or Diesel?

Question 1

WHAT with floods and occasional power failures, I have suggested to our management that some sort of emergency power source be provided, because certain of our processes must not be interrupted. I am working at the moment on a plant to provide 100 kw. Should this be gasoline or diesel? The gasoline engine I understand is much cheaper in first cost, though more expensive to operate; the diesel has possibilities for peak-load tie-in. Diesel operating costs are readily available, but do any readers have operating and cost statistics on gasoline engines in stationary service, showing something of costs at various loadings, assuming constant engine speed?—A.V.K.

Belt Wabbling

Question 2

WE HAVE several flat belts in our plant that continually wabble across pulley faces. Some are leather and others of rubber construction, varying in width from 4 to 12 in. They are apparently of liberal design and operate at moderate speeds of 2,500 to 3,700 ft. per min. I am unable to locate the cause of the trouble and would appreciate learning about experiences of *Power* readers in correcting this condition.—R.E.T.

Suitable answers from readers will be paid for if space is available for publication.

REMOVING SOOT FROM AN ECONOMIZER

Answers to June Question 1
The Question

OUR *economizer is provided with a soot hopper, from the bottom of which soot is piped to our ash-disposal system. A water connection is provided in the hopper for sluicing soot down the pipe. We experience considerable difficulty with plugging of this line, and find it necessary to take the line down to clean it. Can* POWER *readers suggest how this trouble can be eliminated or made less bothersome?*—H.C.S.

Several Possible Causes of Non-Removal of Soot

H. C. S.'s trouble may be caused by any one of a number of factors. Among these are: improper slope of the soot hopper which builds up dust on the sides; attempting to open the sluice-gate too rapidly which allows large quantities of partially wetted material to block the pipe; and lack of booster streams of sluice water in horizontal rows of soot-disposal lines.

The first trouble can be eliminated by baffling or re-designing the hopper. Where this is impossible, a stationary soot blower can be installed to force accumulated material down into the hopper before sluicing operations are started. Opening the sluice-gate too rapidly is primarily a problem of training and can be prevented by proper instruction and supervision.

Absence of booster streams of water can be remedied by drilling and tapping elbows or tees at the beginning of horizontal-piping runs and introducing high-pressure sluice water at these points. Direction of the water jet should be in the direction of flow through the soot piping. Where stoppages occur in vertical runs, provision for introducing a jet of water on the lower side of the accumulation will often obviate taking the pipe down for cleaning. In any case, wherever piping changes direction, tees or crosses with blank flanges for cleanout and inspection should always be included in the design.

New York, N. Y. S. H. COLLINS.

Keep Water Away From Soot

THE PROBLEM of removing soot from the hopper below an economizer is one best solved by keeping water away from the soot. Even with gas-fired units, there is a small amount of refractory carried over in the flue gas, and if coal is the fuel, the amount of mineral carried over as ash is considerable. After being heated and dried thoroughly by flue gas, this material in the soot acts as a quick-setting cement which requires only the presence of water to set, sometimes forming a mass hard enough to require considerable force to dislodge.

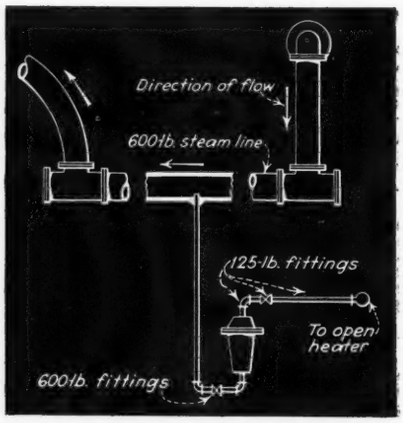
Since soot in the economizer hopper is largely carbon, with perhaps a small percentage of tar from the fuel in addition, it can best be handled by some sort of air-conveying system. If the distance between hopper and ash-disposal system is short, a small nozzle set into the line just below the hopper gate, and directed toward the ash-disposal system, will probably carry the fine soot and ash as far as the system. If the distance is greater, a second hopper, set above the ash-disposal unit, serves as a settling tank for the mixture of air and soot, allowing the soot to settle out before being fed, by gravity alone, into the ash-disposal system.

Flow of soot, both from the economizer hopper and the small settling hopper, can be speeded up advantageously by the use of an electric or air-driven vibrator, attached near the bottom of the conical section. The jarring of the vibrator will prevent bridging or hanging-up within the cone.

The soot H. C. S. wishes to move is almost identical with the principal product of a carbon-black plant, where mechanical conveyors or air flow are used. But in every case, especial care should be taken in keeping the material from coming into contact with water, because of the paste-forming tendencies of the two substances and the forming of relatively hard cakes upon drying.

If the distance is short, and the soot accumulation slight, a mechanical conveyor, formed by running a chain through a 2-in. pipe—or larger if larger amounts of soot are to be handled—will remove the soot, and can be worked by manpower.

Longview, Tex. ELTON STERRETT.



WHAT'S WRONG WITH THIS PICTURE?—XVIII

High-Pressure Trap Installation

There are at least nine errors shown in this drawing. Make a list of those you recognize, then compare with the list on page 467

AIR-COMPRESSOR DIAPHRAGMS

Answer to June Question 2
The Question

THE *rubber diaphragms in our air-compressor unloaders have a very short life. Can any one tell me of a substitute that would be sufficiently flexible and give longer service?*—E.F.V.

Uses Synthetic-Rubber Compressor Diaphragms

SOME time ago we were faced with E. F. V.'s problem of frequently replacing rubber air-compressor unloader diaphragms. Rapid deterioration of this

rubber was apparently caused by oil from compressor cylinders. Similar trouble was experienced with other diaphragms exposed to the action of oil and particularly with those of turbine-auxiliary, oil-pump control valves where rubber is in direct contact with the turbine lubricant.

After experimenting with various types of natural-rubber and impregnated-sheet materials, it was finally decided that this rubber was unsuitable in the presence of mineral oils. The problem was finally solved by using synthetic rubber. This material is impervious to action of oil and diaphragms may now be obtained of fabrics completely impregnated with synthetic rubber or made with a natural-rubber interior and protected on the exterior with a layer of the synthetic product. Experience has proven that these diaphragms have all the flexibility of the older type and last 2 to 3 times as long in service.

St. Louis, Mo. O. C. MILES.

WHAT'S WRONG WITH THIS PICTURE?—XVIII

High-Pressure Trap—See page 466

ERRORS shown in the drawing on page 466 include:

1. Drip line improperly located. The velocity of steam flowing in a line tends to carry water in the direction of flow. The drip should be taken off the bottom of the header outlet.

2. Drip line extends into pipe. Drip piping should be flush with inside of main. Otherwise water accumulates.

3. No valve at header. Whenever a line is taken off a header a valve should be placed at the take-off point so that it can be closed in case of accidents to the branch line.

4. No free-blow valve on drip line. A free-blow valve is needed to drain the line while warming up or until sufficient pressure is built up to overcome any back-pressure in trap-discharge system.

5. No test valve on trap. A test valve should be placed between the trap and the discharge-line valve to detect leakage or other defects.

6. No check valve in trap-discharge line. A check valve prevents back-flow of condensate from return line into main when steam pressure is removed.

7. No bypass around trap. A bypass enables the line to be drained when the trap is out of service for repairs or other reason.

8. Low-pressure fittings in trap-discharge line. Unless a relief valve is used, this line should have the same strength as the inlet line.

9. Wrong method to handle trap discharge—Piping high-pressure drips directly to an open heater is hazardous. These drips should be handled in a separate receiver having a relief valve, flashed to a low pressure, and then the mixture of low-pressure water and steam piped to the feedwater heater.

THE ENGINEER'S BOOKSHELF

Industrial Wiring

INDUSTRIAL ELECTRICITY AND WIRING (Second Edition)—*By James A. Moyer, Director of University Extension, Massachusetts Department of Education; and John F. Wostrel, Supervisor in Charge of Industrial Subjects, Division of University Extension, Massachusetts Department of Education. Published by McGraw-Hill Book Co., 330 W. 42nd St., New York, N. Y. 502 pages, 5½x8 in.; 281 illustrations; 35 tables. Price $2.75.*

The first edition of this book appeared in 1930. Since then there have been many changes in electric-wiring equipment and in the national and local requirements controlling their installation and operation. This edition has been revised and new material added to meet present day practice.

It has been prepared for those in the electrical industry who want a better understanding of underlying principles and standard methods of construction and includes descriptions of action and application of such equipment as generators, motors, and transformers. Several chapters are devoted to practical applications in electric lighting and power, including planning of circuits and estimating of costs. Among the more important chapters may be mentioned: wiring old buildings and unit costs, industrial lighting, grounding of systems and equipment, calculation of wiring systems, electric generator and motor wiring, outdoor wiring, and distribution systems.

Particular attention has been given National Electrical Code requirements, which makes the book of special value to electricians and others interested in electric-wiring and power-application problems.

BRIEF REVIEWS

ANNUAL REPORT OF THE SMOKE ABATEMENT LEAGUE, CINCINNATI, OHIO, (1936). *Frank H. Lamping, League Supervisor, 2901 Union Central Bldg., Cincinnati, Ohio.*—10-page mimeographed report describes progress made during past year in smoke prevention and control in Cincinnati.

WAVERLY HANDBOOK (1937). *Published by Waverly Oil Works Co., Pittsburgh, Pa. Price $1.50*—900 pages of technical, engineering and chemical information relating to processes of refining, standards, and lubrication problems, both industrial and automotive.

CURVES FOR THE CLASSIFICATION OF COAL. *U. S. Bureau of Mines, Washington, D. C. Price not stated*—A series of tables for determining dry, minimum-free, fixed carbon of a coal from various analyses. Information Circular No. 6933, 12 pages.

LEFAX DATA (1937). *From Lefax Inc., Philadelphia, Pa.*—Recent Lefax fillers include: No. 37-6, "Lubricating Oils;" No. 37-9, "Properties of Saturated Water Vapor With Air;" No. 37-10, "Psychrometric Chart for Air-Conditioning Calculations;" No. 37-12, "Seamless Boiler Tubes;" No. 37-24, "Gas Conversion Factors."

WATER RESOURCES PAPER No. 72. *Free from Dominion Water and Power Bureau, Ottawa, Canada*—Results of investigations made by the Dominion Hydrometric Survey during 1930-32. 293 pages of stream-flow data plus reports on temperature and precipitation at a number of points in British Columbia, together with evaporation records at four points in the province.

Piping

MANNING FORMULA TABLE FOR THE SOLUTION OF PIPE PROBLEMS (1937)—*By Horace W. King, Professor of Hydraulic Engineering, University of Michigan. Published by McGraw-Hill Book Co., 330 W. 42nd St., New York, N. Y. Fabroid cover, 351 pages, 6 x 9 in. Price $5.00.*

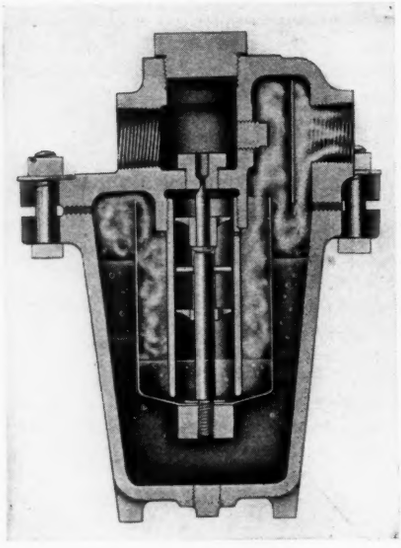
These 351 pages of tables give a solution of the Manning formula throughout the range of conditions ordinarily encountered in pipe problems—for flows of 0.001 to 10,000 cu.ft. per sec., and for pipelines with diameters up to 200 in. Tabulated values are dismaters in inches corresponding to different rates of loss of head and different degrees of roughness. Usually it is possible either to take results directly from the table or to obtain them sufficiently close by inspection or by mental interpolation. They are applicable to sewers and drain tile as well as to pressure pipe and circular conduits of all types, flowing full.

Diesel Data

DIESEL HANDBOOK (4TH EDITION)—*By Julius Rosbloom. Published by Diesel Engineering Institute, 443-445 Hoboken Ave., Jersey City, N. J. 720 pages, 5 x 7 in. Semi-flexible cover. Price $5.*

This enlarged edition includes data on all types of diesels for all services. Illustrations are large and text simple and readable. Part of the book is in question-and-answer form, and such supplementary and associated information as temperatures, oils, materials, etc., is included.

WHAT'S NEW IN PLANT EQUIPMENT



STEAM TRAP

BUCKET-TYPE steam trap designed for straight-line installation, which permits inspection and cleaning without disturbing pipe connections. Plug at top gives access to seat. Only two moving parts: bucket and seat, which is said to afford quick positive action. Positive water seal prevents blowing steam. For condensate drainage up to 150 lb.

Cochrane Corp., 3106 N. 17th St., Philadelphia, Pa.

INSULATED CABLE

INSULATING compound, "Flamenol", a synthetic substance similar to rubber in its characteristics, but will not burn, and highly resistant to moisture, acids, alkalies and oils. "Flamenol"-insulated cable designed for power and control circuits at 600 volts and less, and for operation at a maximum copper temperature of 60 C.

General Electric Co., Schenectady, N. Y.

FIN COIL

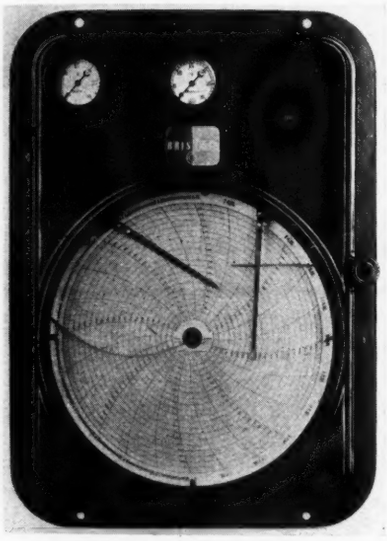
REFRIGERATING fin coil made on order to fit individual specifications in fin sizes of 3x3 in. with fin spacing of $\frac{3}{8}$, $\frac{1}{2}$ and $\frac{3}{4}$ in; also in fin sizes of $1\frac{3}{4}$x$1\frac{3}{4}$ in. with fin spacing of $\frac{3}{8}$ and $\frac{1}{2}$ in. All coils made with $\frac{5}{8}$-in. refrigerant tubing. With exception of copper tubing, all coil parts are aluminum. Separate return bends avoided to eliminate possibility of leaks.

York Ice Machinery Corp., York, Pa.

FAN-COOLED SQUIRREL-CAGE MOTOR *(Photo right)*

MOTOR frame contains two seperate sets of air ducts, one internal and other external. Internal fan on rotor circulates warm air through internal ducts, walls of which are cooled by external fan blowing air through external ducts. Housing is designed so that fresh grease enters outside edge at top of bearing and excess or used grease is discharged at bottom inner edge to overflow sump.

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.



ROUND-CHART PYROMETER CONTROLLER

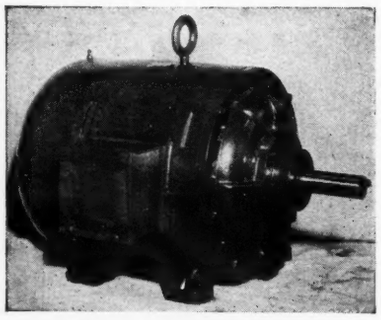
"PYROMASTER CONTROLLER" is a potentiometer-pyrometer, made either as a pneumatic or electric instrument. Automatically self-balancing and self-compensating for cold-end temperature changes. Pen arm actuated in small steps that follow each other at a rate depending on rate of change in thermocouple temperature. Said not to be affected by plant vibration. Bulletin 489.

Bristol Co., Waterbury, Conn.

MAGNETIC CLUTCH

CAGE FLOATS around friction elements and said to thereby eliminate possibility of uneven wear. Latch-and-groove lock design provides quick adjustment. Either dry or wet application; automatic self-alignment.

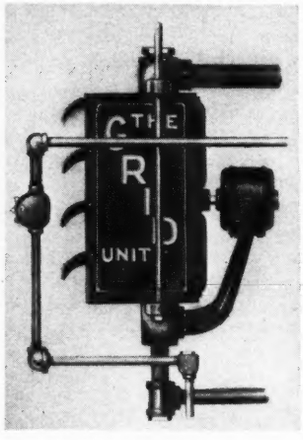
Stearns Magnetic Mfg. Co., Milwaukee, Wis.



HUMIDIFIER

"GRID" humidifier may be attached either in front or back of a unit heater, or as an individual unit. Operation of humidifier is at temperatures higher than room, which causes quick absorption of humidifying fluid or gas. For manufacturing plants that require variation in humidity conditions due to special processes or conditions.

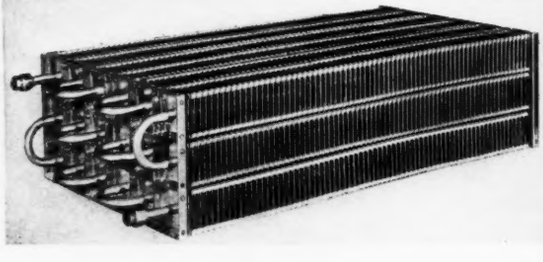
Unit Heater & Cooler Co., Wausau, Wis.

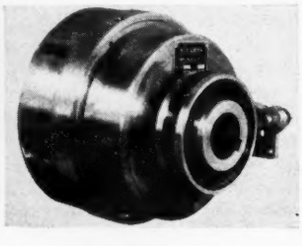


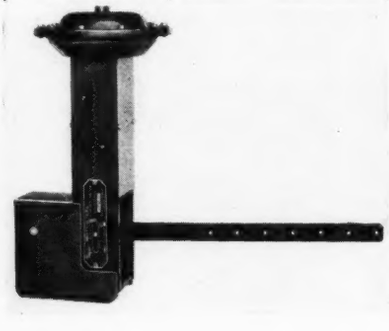
LEVER MOTOR

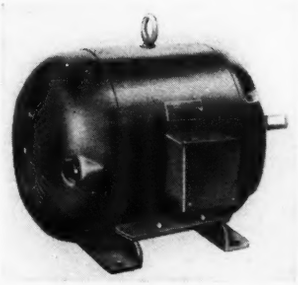
FOR dampers, lever-operated and butterfly valves, electric rheostat for variable-speed motors, etc., this all-steel welded lever motor has deep diaphragm to give smooth modulated action. Power of either up- or down-stroke action can be increased or decreased by spring adjusting nut. Lever action can be reversed by substituting another lever and transposing fixed and movable pivots. May be operated by remote manual control, electro-pneumatic switch, or by pneumatic controller.

Taylor Inst. Cos., Rochester, N. Y.









TOTALLY-ENCLOSED FAN-COOLED MOTOR

SKELETON-TYPE stator, deeply grooved on outside to increase radiation, has totally-enclosed ball-bearing endplates. External blower on front end directs cooling air around front endplate through a baffled back endplate down over bearing. Special alloy-steel shaft, cartridge-type ball bearings. Front end bearing carries thrust while back bearing is floating self-aligning type.

Wagner Electric Corp., 6400 Plymouth Ave., St. Louis, Mo.

BELT COVERING

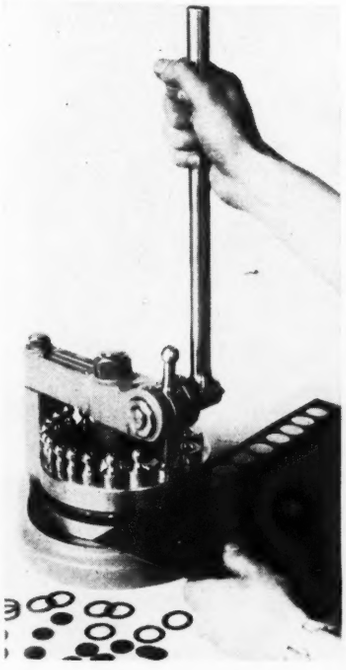
A LIQUID covering, said to give a leathery adhesive surface to pulley, is applied in two coats. First coat dries in one hour, second in five hours. Manufacturer states that product provides clean and dry surface which will not attract dust or lint. One gal. covers 100 sq.ft. of pulley surface, two coats.

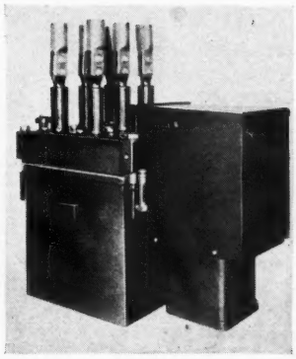
Warren Pulley Cover Co., Inc., 15 Union St., Lawrence, Mass.

WASHER PUNCH

18-DIE PUNCH (size range of $\frac{1}{8}$ to $1\frac{3}{8}$ in.) for fibre, steam packing, asbestos, leather, felt, cork, rubber, Bakelite, etc., up to 1/16 in. thickness. Dies mounted in eccentric turret plate. Centering system said to insure concentric punching.

Ideal Commutator Dresser Co., 1025 Park Ave., Sycamore, Ill.





OIL-BLAST CIRCUIT BREAKER

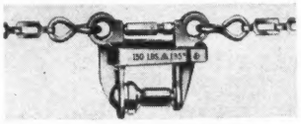
TYPE FK-45, 75,000-kva. interrupting rating, is a non-oil-throwing breaker with plate-steel rectangular tank, separating chamber, silver-to-silver main contacts, renewable arcing contacts, oil-blast baffles, and "Herkolite" bushings. Three current sizes, 600, 1,200 and 2,000 amp.

General Electric Co., Schenectady, N.Y.

HEAVY-DUTY DISCONNECT SWITCH *(Photo above)*

FOUR THOUSAND amp., 23-kv. outdoor-form, multiple-blade, straight-line disconnect switch is equipped with blade locks and silver-to-silver contacts. One terminal for heavy copper tubing, other for flat bars.

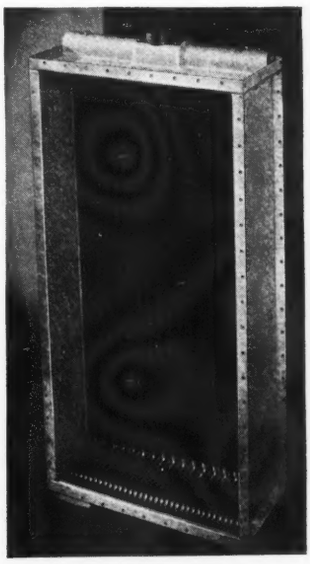
Delta-Star Electric Co., 2400 Fulton St., Chicago, Ill.

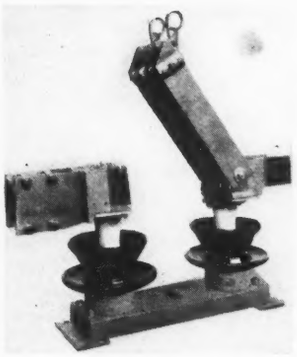


BLAST HEATER

FOR HEATING, ventilating, air-conditioning and process applications, this blast heater has patented expansion bend to allow each tube to expand and contract without affecting adjacent tubes. Seamless cylindrical headers and tubes. All steam-carrying passages of heater condenser are pure copper or copper alloy to eliminate electrolysis. Bulletin 337.

Modine Mfg. Co., Racine, Wis.





PUSH BUTTON CONTROL STATION

SILVER contacts mounted on Bakelite base. Box and cover die cast. Box is tapped for conduit entrance, and wiring may be made by removing cover without disturbing conduit connections. Colored molded-Bakelite buttons.

Monitor Controller Co., Baltimore.

V-BELTS

USE OF CORDS, soaked with liquid rubber, as tension members of V-belts said to increase belt life. Rubber-soaked cords cement themselves to surrounding rubber belt, minimizing loosening of tension members as belt flexes and bends around sheaves. Used in Gates "Vulco" belts.

Gates Rubber Co., Denver, Colo.

HEAT-OPERATED RELEASING LINK

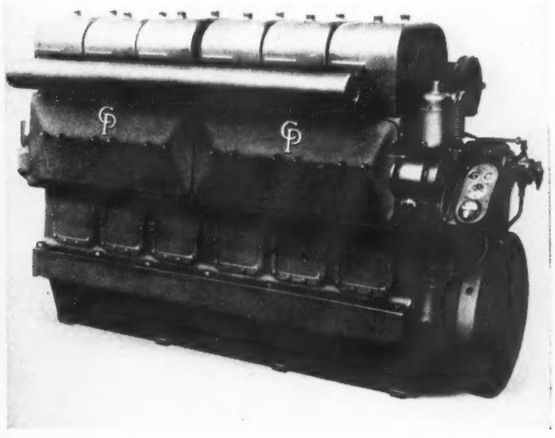
"QUARTZOID" link sensitive, immune to corrosion, and shatters at its rated temperature. Ability to carry loads up to 150 lb. eliminates necessity of ganging several solder links. *(Photo left)*

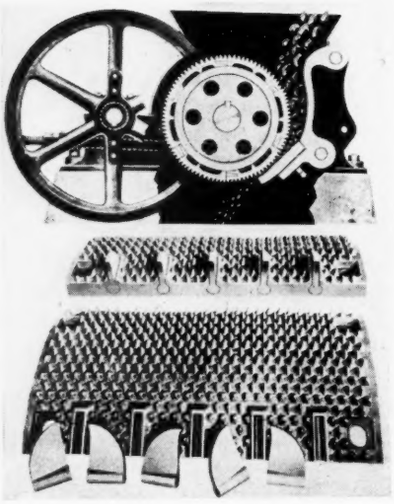
Grinnell Co., Inc., Providence, R. I.

HEAVY-DUTY DIESEL

TYPE 8 CP diesel, designed for continuous heavy-duty service, is 4-cycle, direct-injection engine. 3, 4, 6 or 8 cylinders deliver 90 to 300 hp. at 600 or 720 r.p.m. 8-in. bore, $10\frac{1}{2}$-in. stroke. Bosch fuel pump. Base and A-frame alloy-iron castings; die-pressed and heat-treated crankshaft. Cast nickel-chromium iron liners; high-tensile alloy-iron pistons; drop-forged, heat-treated alloy-steel connecting rods.

Chicago Pneumatic Tool Co., 6 E. 44th St., New York, N. Y.





SINGLE-ROLL CRUSHER

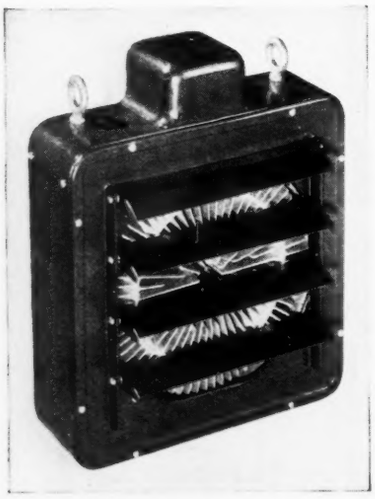
DESIGNED for preparation of stoker and smaller-size coal, this unit has renewable segments which carry thin, sharp, pyramid and spear-point teeth; also insertable "Wejtite" feeder teeth for reduction of large coal. Manufacturer states that teeth, together with pattern of spacing, minimize degradation by causing piercing action rather than mashing. New breaker plate eliminates boiling of feed and increases capacity.

Jeffrey Mfg. Co., Columbus, Ohio.

INDUSTRIAL FAN-TYPE HEATER

MOTOR-DRIVEN, 4-bladed aluminum fan, running on graphite-impregnated bronze bushing, dissipates heat from surface of circular grid and circulates warm air. Heat can be directed wherever needed by moving adjustable reflectors. Heat source is cast aluminum grid, poured around a Calrod heating element.

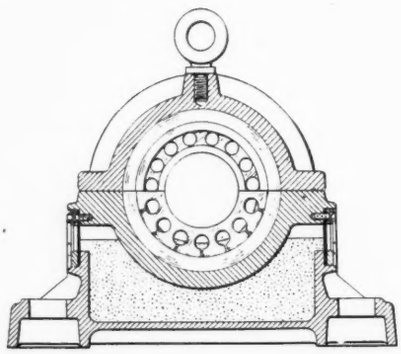
American Foundry Equipt. Co., 555 S. Byrkit St., Mishawaka, Ind.



OIL-FILM BEARINGS

THESE bearings are interchangeable in size with existing types of ball and roller bearings made to international standard dimensions. It is claimed that their life is unlimited as there is no metallic contact; the load is carried entirely on oil film. Hub journal is formed with lips on either side that collect oil flowing by gravity from housing and, due to journal hub rotation, oil is forced under centrifugal pressure out between various shoes or blocks. Splash guards collect excess oil, which passes through holes in the guard and is diverted down in two streams to oil sump in bearing housing. Two types: (1) medium type 300 series cylindrical bearing for radial loads, permitting axial float or expansion of shaft —lateral movement taking place within oil film without resistance; and (2) medium 1,300 series spherical or self-aligning bearing for thrust or location bearings. In both types, outer members or races are locked in a lateral position in housing.

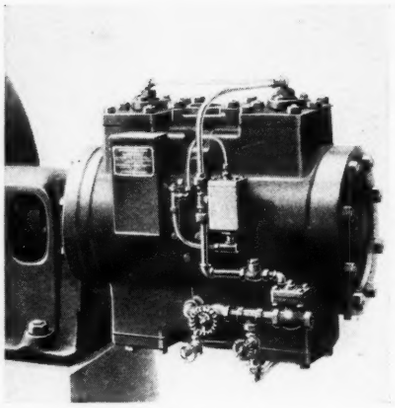
Fast Bearing Co., Hampden Ave. and 23rd St., Baltimore, Md.



PORTABLE PYROMETER

MILLIVOLTMETER portable indicating pyrometer measures temperatures up to 3,000 F, using thermocouple and extension leads. Cobalt magnet said to permit increased sensitivity and widened scale for more accurate readings. High-resistance millivoltmeter movement is double-pivoted and shielded to prevent effects of stray fields. Molded dust- and moisture-proof Bakelite case. Both double- and single-range instruments.

The Bristol Co., Waterbury, Conn.



START-STOP CONTROL AND UNLOADER FOR COMPRESSORS

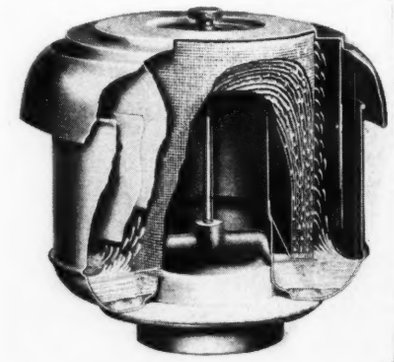
AUTOMATIC start-and-stop control plus automatic loading and unloading for motor-driven, single horizontal compressors said to be obtained with magnetic unloader without extra piping or valves. Device operates on standard electric equipment and can be installed wherever conventional electric starter is used for controlling compressor motor. There must also be a pressure switch to operate pilot circuit. Pressure-switch control is transferred electrically from motor starter to magnetic unloader, and either position may be selected at will.

Worthington Pump & Machinery Corp., Harrison, N. J.

OIL-BATH AIR FILTER

NEW FEATURE of this filter is backfire valve which eliminates relief valves on intake-pipe elbows. Interior construction follows general "Air-Maze" principles. When air is drawn under hood edge and passes down skirt, oil in sump automatically washes filter element made of alternately placed flat and crimped galvanized screens. Hood fitted with complete backfire valve. For capacities of 450 to 4,000 c.f.m. of air.

Air-Maze Corp., 812 Huron Road, Cleveland, Ohio.

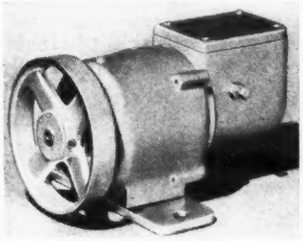


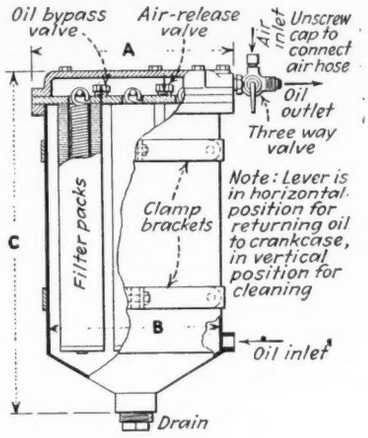
DRIVE PROTECTOR

"SAF-DRIV" relay, for protection against motor-drive or belt failure is mounted so pulley is driven by belt or drive being protected. Pulley drives a shaft carrying centrifugal governor. In operation, rotation force tips a mercury switch to close circuit. If drive fails or belt breaks, mercury switch tips back, breaks

circuit, and sounds alarm or shuts down system or both, as desired.

General Combustion Corp., Engineering Bldg., Chicago, Ill.





LUBE-OIL PURIFIER

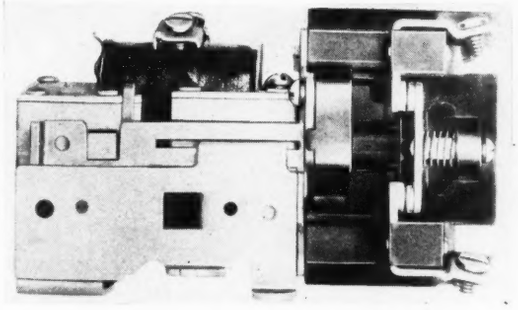
"STREAM-LINE" filters have several packs made up of hundreds of specially treated paper disks under spring pressure. Oil passes between disks, leaving separated solids and moisture on outer edges. Filter is cleaned by air pressure back through unit, draining impurities from base plug. Filtering packs said to last many months without replacing.

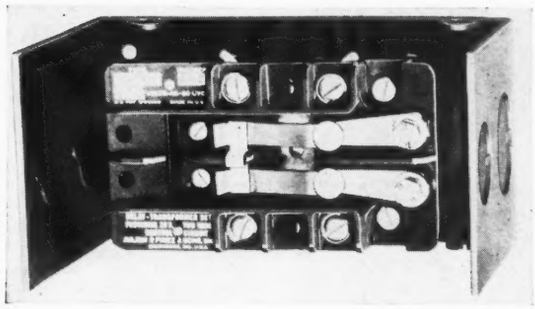
Skinner Purifiers Inc., 2231 Dalzelle St., Detroit, Mich.

A.C. MULTIPOLE MAGNETIC CONTACTOR

FOR CONTROLLING small single-phase and polyphase motors, or as a flexible relaying device for comprehensive control systems, this contactor has double-break silver contacts, layer-wound coils, and a laminated steel-plate, E-shaped magnet. Flash-overs between poles are minimized by hot-molded arc barriers. Unit can be furnished as a magnetic switch mounted in sheet-metal case. Maximum rating of 10 amp. at 600 volts. Range of two to eight poles.

General Electric Co., Schenectady, N. Y.





RELAY-TRANSFORMER SETS

THESE UNITS operate on "magnetic leakage" principle and produce own supply of low voltage for control circuit (20 volts). Transformers are built into relays to form compact unit. Of use where electrical loads to be handled exceed current-carrying capacity of sensitive control instruments. Bulletin AT/R.

Julien P. Friez & Sons, Inc., Baltimore, Md.

INDOOR OIL CIRCUIT BREAKERS

(Photo right)

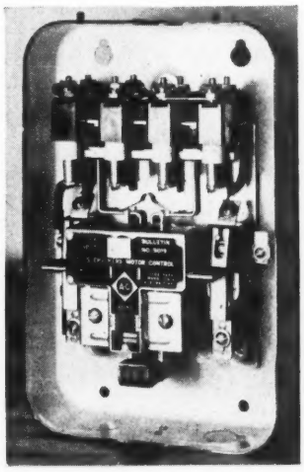
FOR INDUSTRIAL and central-station use where minimum space is available, 50,000-kva. breakers are manually or electrically operated, non-automatic or automatic, single throw with adaptable mounting arrangements. "De-ion" interrupter contacts, condenser bushings, single square tank, hydraulic bumpers, and silver-to-silver main contacts. Rated 600 amp., 15 kv.; 1200 amp., 7.5 kv.; and 2,000 amp., 5 kv. Either 2- or 3-pole single throw.

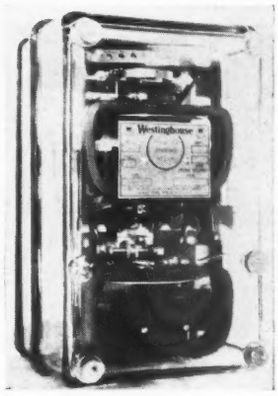
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

MOTOR STARTER

TYPE AP-7 across-the-line motor starter equipped with special "Ruptor" enclosing chambers which confine and depotentiate arc formed by circuit interruption. Vertical make and break, enclosed temperature overload relays, individual pole units mounted on steel chassis, large silver double-break contacts, and pilot circuit isolated from motor circuit. Sizes: 7½ hp. at 440 and 550 volts, 5 hp. at 220 volts, and 3 hp. at 110 volts.

Allis-Chalmers Mfg. Co., Milwaukee, Wis.

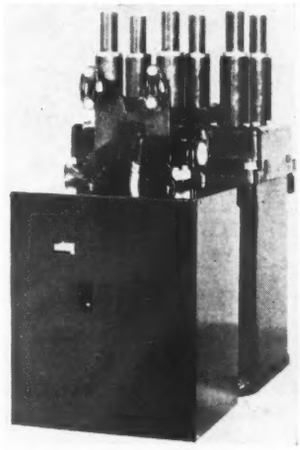




DIRECTIONAL OVERCURRENT RELAY

TWO TRANSFORMERS, connected in open delta, permit directional relaying of ground faults. Overcurrent element has tap range of 4 to 15 amp. and operates from zero sequence current. Directional element operates from negative phase sequence voltage and current derived from filters. Will operate on 4 amp., 1 volt in phase. Eight terminals, shockproof gravity target, full glass cover.

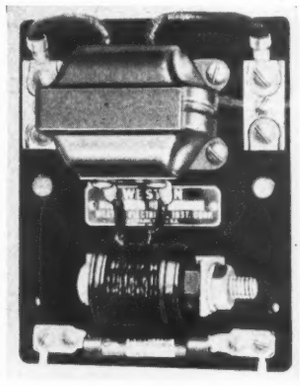
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

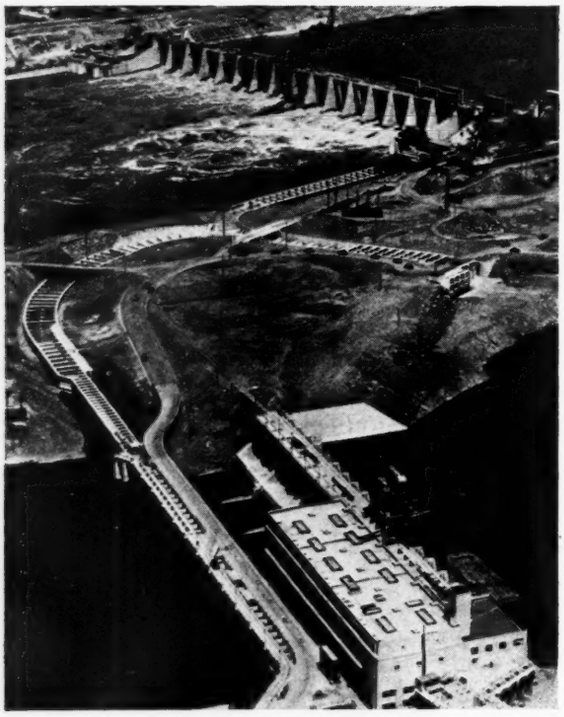


TRANSFORMER RECTIFIER

MODEL 9980 combines a 110-volt a.c. transformer and a copper-oxide rectifier and is designed to provide 6-volt d.c. for power-relay operation. Output of transformer is 120 milliamps continuous, or 200 intermittent. Resistor across output protects sensitive relay contacts from "kick-back" voltage.

Weston Electrical Instrument Corp., Newark, N. J.





UNCLE SAM REMEMBERS HIS FISH

A VIEW of the giant Bonneville power and navigation dam on the Columbia River between the states of Washington and Oregon, being completed at a cost of $42,500,000 for an ultimate capacity of 665,000 hp. At lower right are the locks and power house, and directly in front of the latter are ladders which will permit the famous Columbia River salmon to reach the headwaters of the river to spawn — *Wide World Photo*

POWER LINES

Chicago Power Show to Be Held Oct. 4-9

New types of power-plant equipment and machinery for industries that utilize mechanical engineering will be exhibited at the Chicago Exposition of Power and Mechanical Engineering, to be held at the International Amphitheatre, Chicago, Ill., Oct. 4 to 9. To date approximately 60% of available space is under contract to exhibitors.

Equipment on display at the Exposition will include: fuels and combustion equipment; refractories; steam-generating equipment; steam distribution; accessories; piping and fittings; prime movers; pumps and hydraulic equipment; electric generators and motors; electrical transmission, distribution and control devices; power-transmission accessories; tools and power-driven units; materials-handling systems; factory air-conditioning equipment; lubricants; refrigerating machinery; operation and maintenance materials.

The Exposition is under the direction of Charles F. Roth, Grand Central Palace, New York, N. Y.

Standby Plant at Oslo Erected in Record Time

To assure the power supply of Oslo, Norway, which is normally obtained from hydroelectric power stations, two Velox generators and a 32,000-kw. turbine have been installed. Each Velox generator is built for 167,000 lb. of steam per hr. at 385 lb. per sq. in., steam temperature being 800 F and feedwater is supplied at 140 F. Oil is the fuel.

There was less space available for the whole new plant (including sufficient room for a third similar Velox and a 20,000-kw. electric boiler) than that which was taken up by the old boiler house alone. Today 40 kw. per sq. yd. floor surface are produced as against 10 kw. in the old power house, which was itself far from being amply dimensioned. Work on dismantling the old boiler house began at the beginning of 1936, and new foundations were in place by May and June. Erection work on the Velox units and the turbine was begun in July and the plant was in operation by the middle of November.

This is said to be the first occasion in the history of technical development in which a complete power plant of such considerable output, consisting of steam generator, turbine with apparatus, piping, etc., has been mounted complete and tested on the manufacturer's test bed.

Arc-Welding Meeting

At a special course in arc-welding design held recently in Cleveland by the Lincoln Electric Co., 23 professors and instructors, representing 21 different colleges, met to gather first-hand information on welding. The course, which began June 14 and continued for five days, followed in general the advanced 5-day course in arc-welding design given regularly by Lincoln Electric in conjunction with the John Huntington Polytechnic Institute.

Socony-Vacuum Lubrication Film

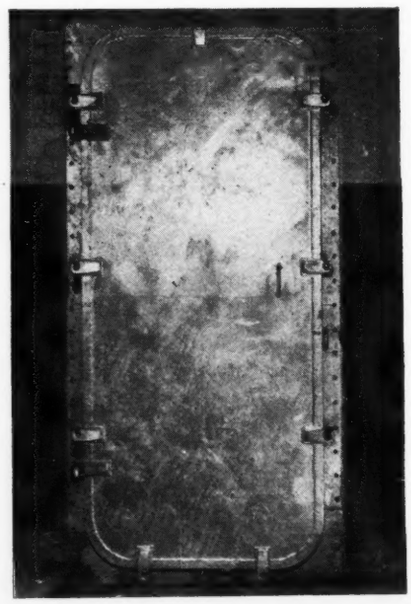
Lubrication has joined the movies. A motion picture dramatization of correct lubrication methods in modern industry, prepared by the Socony-Vacuum Oil Co., was shown for the first time recently in the preview theatre of Radio City Music Hall, Rockefeller Center, New York. The film is done in a "March of Time" style, and animated drawings and striking photography are used to illustrate correct lubrication of various types of machinery.

The film will be shown to business organizations and to groups of plant managers and factory executives in industrial communities throughout the country, according to P. M. Gordon, manager of the Industrial Dept. of Socony-Vacuum.

Webster Station Protects Bus Room Against Flood

Power plants today are giving much thought to the subject of flood protection. In June *Power* was reported work done at Springdale in rising vital generator leads and bulkheading all openings to protect the station against a 30.5-ft. water rise. More recently, the Webster steam station of the New England Power Service Co., Webster, Mass., has installed two galvanized bulkhead doors to protect the 2,300-volt bus room, one of which is shown in the photo.

These doors are 3¼ ft. wide and 7¼ ft. high, of ⅛-in. steel and weigh 400 lb. each. Of welded trussed-steel construction, thoroughly galvanized, they fit into special steel casings with solid rubber gaskets where the door fits into the casing. Nine ¾x4-in. bolts, attached to the casing, engage lugs welded to the doors. There are 68 lag screws in the casing, bolted solidly to the brick wall in which are set lead expansion sleeves to receive lag screws.



Should water seep into the bus room, provision has been made to remove water with an Allis-Chalmers centrifugal pump, capable of moving 800 g.p.m. against a

To Be An Engineer . . .

By John M. Drabelle *

Mechanical & Electrical Engineer,
Iowa Electric Light & Power Co.

WHAT are the requirements which, when met, make a man a successful engineer? The Society for the Promotion of Engineering Education, after a very thorough study, reported that technical knowledge and advanced learning constituted only 15% of the total requirements — and this from a group of educators!

The greatest essential, in my mind, after you have a thoroughgoing knowledge of your life's chosen work, is your ability to convey that knowledge to others, to get them to work for and with you, and further to maintain discipline in your organization not by the fear of dismissal or lay-off, but by commanding the respect of those who work for you. I feel that comparatively few executives really appreciate the human side of the power station, and the human elements that go to make up the success or failure of its operation.

If you want to get along in this business, there are some basic requirements. You must first have good health and a sound body and take care of yourself. The sick and irritable boss conveys his ill feelings to his employees, and it is all too true that any organization is but the lengthened shadow of the man at the top.

The next basic requirement is a thorough knowledge and understanding of your work. Men under you are a jury. If you want to get the number of a man, go on a fishing or hunting trip with him. If there is any meanness in him, it will soon show up.

Don't try to run a bluff, because you can't get away with it. Your men have your number. When you don't know, say so, and try to find the answer.

The third basic requirement is to be absolutely honest and sincere in your dealings with your men. If you have a man who has pulled a "boner," don't bawl him out in front of a group of his fellow employees, but call him into the office and have a friendly talk with him. Tell him in simple language what the mistake was, the seriousness of it, and that it should not be repeated. The Golden Rule is worth following in dealing with your men.

Where disciplinary action is required, the rule of rigid honesty and fairness is absolutely essential. Weigh the stories, often conflicting, of your men as you weigh the merits of an engineering proposition. Give every man a chance to tell his story first, at an open hearing, then review the stories privately with the men involved. It is a good rule, after you've heard all there is to hear, to wait 24 or 48 hours, then check a little further if necessary, before rendering a decision. Hasty decisions are generally incorrect and faulty.

Don't indulge in petty grafting—the accepting from sales people of anything beyond the ordinary cigar and occasional lunch. The salesman gets your number immediately, and sooner or later so does the "Boss."

Don't be a "Yes" man. When your superior asks your opinion, give it; don't just give him the answer you think he'd like to hear.

Don't employ your relatives. They may need a job, but be sure it's elsewhere. As a rule, if you make a relative do his work, you're in bad with the family; if you don't, you're in bad with your men. The same rule holds with the employment of too many members of some lodge, church or other organization with which you may be affiliated.

Don't make a pet of any man in your employ. Think back to grade-school days when the teacher's pet was uniformly the object of contempt of the "gang."

Don't disregard the suggestions of men working for you. The man offering a suggestion has doubtless given the idea considerable thought. The suggestion may not have merit, but receive it courteously in the spirit in which it is offered, then investigate before approving or disapproving it. Many valuable suggestions in industry today have come from employees.

Remember that in most cases your superior officer is not a technically trained man, but a business man running a business. The power plant is just one of the component parts. When you submit a report dealing with an improvement large or small that will require the expenditure of money, show in the report the reduction in operating expenses in dollars. Your "Boss" will understand a dollar sign much better than a percentage sign.

Be a good housekeeper. A clean, neat and orderly power station is invariably an efficiently operated one. It is also always a safe place to work.

*An abstract of a paper before the 32nd annual convention of the Iowa State Ass'n, N.A.P.E., June 18-19, in Cedar Rapids. Among other speakers were Jake Schmall, chief engineer of the Univ. of Neb., Walter Proescholdt, Ia. Elec. Lt. & Pwr. Co., Barney Winger, master mechanic of Morrell Packing Co., and Alex D. Bailey, chief operating engineer, Commonwealth Edison Co. of Chicago.

25-ft. head. The pump will be operated by a direct-connected Wisconsin 4-cyl. air-cooled gasoline engine. Pump and engine are installed near a trap door so that the suction line can be lowered to the floor below, with discharge of water and engine exhaust through an opening in the side of the building.

James H. McGraw, Jr. Elected McGraw-Hill President

Effective June 21, James H. McGraw, Jr., was elected president of the McGraw-Hill Publishing Co., publisher of *Power*, to succeed Malcolm Muir, resigned. Mr. McGraw, Jr., continues as chairman of the board and assumes the additional responsibilities of the office of president.

Following his graduation from Princeton University in 1915, Mr. McGraw entered the service of the company and for 21 years has served actively in various posts connected with its publishing activities. After eight years of service with

HOW GRAND COULEE LOOKS TODAY

A completed foundation section of the Columbia River barrier on the west side of the Grand Coulee Dam. Work on the project is scheduled to be finished in 1938—*Wide World Photo*

James H. McGraw, Jr.

individual papers and groups of papers, he entered the general management of the company as treasurer in 1923, and became executive vice president in 1932. In 1935 he was elected chairman of the board to succeed James H. McGraw, founder of the company.

In 1932 and 1933, Mr. McGraw served as president of the Associated Business Papers and in addition to his work in his own company he has contributed generously of his time and effort to the advancement of business paper publishing. Thoroughly grounded in the editorial tradition, he has applied himself aggressively to keeping the business paper abreast of what is best in modern publishing practice from the viewpoint of both readers and advertisers.

Detroit Holds First Fuel Conference

Power engineers and industrial executives from lower Michigan and northwestern Ohio met on June 15 for the first Fuel Engineering Conference patterned after the 19 fuel engineers' meetings conducted in Cincinnati, Ohio, since 1934. The meeting, sponsored by Appalachian Coals, Inc., was held in Detroit.

Five papers were presented at the meeting, the first by Dr. Reinhardt Thiessen, research chemist, Pittsburgh Experiment Station, U. S. Bureau of Mines, who traced the formation of coal and discussed the scientific reasons why coal from one section of the country varies from that mined in other areas.

"Use Value vs. Scientific Value of Coals for Steam Generation," by B. E. Tate, chief engineer, power plant, National Cash Register Co., Dayton, Ohio, covered in detail each of 16 factors which buyers of steam coals usually consider. A point which fuel engineers have made for many years—that each plant must consider the use value of the coal in an individual plant—was emphasized by Mr. Tate. Concluding, he said, "The use value of coals may amount to very considerable proportions in plant costs. When an informed buyer buys coal for his plant he will first consider use value. Then, after having properly evaluated the coals in that respect, he will compare them according to their scientific analysis."

Discussing "Underfeed Stoker Fuel Beds," R. A. Foresman, chief engineer, stoker department, Westinghouse Electric & Mfg. Co., said, "It is out of the question to produce a set of rules which is universally applicable for burning a given class of coals or any individual coal. However, there are a few fundamental rules." He listed the following:

(1) Maintain active burning lanes throughout the entire length of each tuyere row.

(2) So adjust thickness of the fuel bed on the different portions of the stoker length that the activity of the fuel bed over the entire stoker length is visibly fairly uniform.

(3) Select the desired proportion of excess air for best all round operation, provide reliable and properly conditioned and functioning instruments for the guidance of the operators in maintaining this excess air value, and make sure that as far as can be determined all portions of the furnace are operated with a fairly uniform excess air.

(4) Train the operators to manipulate or regulate the discharge of ash from the furnace so that sufficient ash is maintained on the stoker for its protection but an excessive amount avoided which would tend to set up excessive resistance to flow of air.

"Burning Appalachian Coal in Pulverized Form," the paper presented by Henry Kreisinger, chief research engineer, Combustion Engineering Co., Inc., New York, N. Y., discussed effect of volatile matter on ignition, lighting fire under cold boiler, delayed admission of secondary air, effect of fineness on ignition, effect of moisture, effect of preheated air, completeness of combustion, effect of mixing on combustion, effect of mixing on combustion of gases, effect of length of flame path on mixing, tangential firing, moisture and pulverization, ash and pulverization, fusibility of ash, and furnace design and operation.

E. A. Sitter, chief engineer, power plant, Chevrolet Gear and Axle Company, Detroit, Mich., concluded with "Experiences with Pulverized Coal in an Industrial High-Pressure Steam Plant."

Mr. Sitter described the boiler, combustion control, turbine, reducing and desuperheating station, pulverizers, and reported on the adaptability of pulverized-fuel firing.

"Pulverized-fuel firing," said Mr. Sitter, "lends itself very readily to an industrial plant operating two shifts per day, five days a week."

MEETINGS

American Welding Society—*18th Annual Meeting and Exposition, Oct. 18–22, Hotel Traymore and Convention Hall, Atlantic City, N. J. Miss M. M. Kelley, secretary, 33 W. 39th St., New York, N. Y.*

A.S.M.E. Oil and Gas Power Division—*Annual Summer Meeting, Aug. 18–21, Penn State College, State College, Pa. C. E. Davies, secretary, 29 W. 39th St., New York, N. Y.*

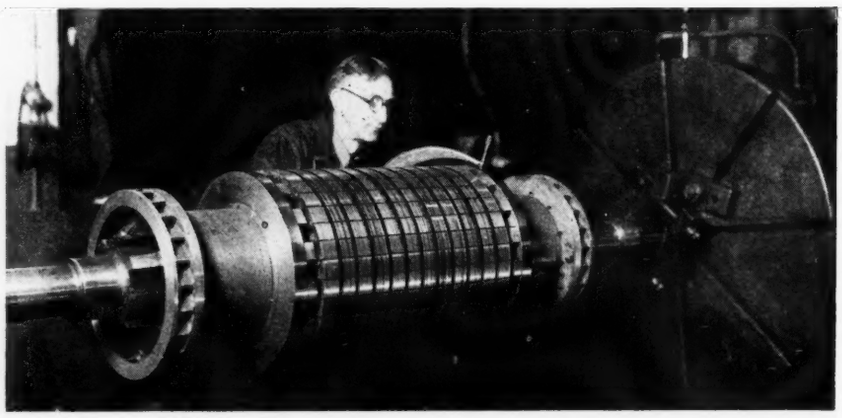
Chicago Exposition of Power & Mechanical Engineering, *International Amphitheatre, Chicago, Ill., Oct. 4-9. Address Charles F. Roth, vice-president of International Exposition Co., Grand Central Palace New York, N. Y.*

Iron & Steel Exposition—*Sponsored by Association of Iron and Steel Engineers, Sept. 28-Oct. 1, Hotel Stevens, Chicago, Ill.*

National Association of Power Engineers—*Mississippi Valley Mechanical & Electrical Show, and 55th Annual N.A.P.E. Convention, Aug. 30 to Sept. 3, Jefferson Hotel, St. Louis, Mo. Fred C. Laufketter, chairman of Executive Committee, N. A. P. E., in charge.*

National Safety Council—*Annual Meeting, Oct. 11–15, Kansas City, Mo. W. H. Cameron, secretary and managing director, 20 N. Wacker Drive, Chicago.*

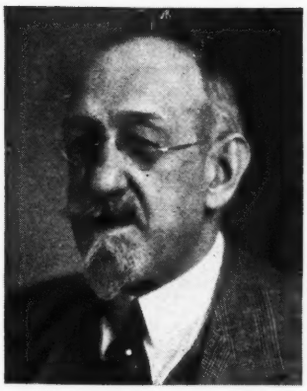
Universal Craftsman Council of Engineers—*35th Annual Convention. Aug. 3-7, Stevens Hotel, Chicago, Ill. Exhibition of power equipment by 150 manufacturers in conjunction with convention. D. W. Haering, 3408 W. Monroe St., Chicago, Ill.*



MACHINING SPRINGDALE'S ROTOR

ONE OF the rotors for the two 3,600-r.p.m., squirrel-cage motors being built at the East Pittsburgh Works of Westinghouse. Motors are designed to drive high-pressure boiler-feed pumps at West Penn Power Co.'s Springdale plant, and are rated 1,750 hp. Oil is supplied to bearings under pressure by a feed pump driven from motor shaft by special gears. In addition, oil rings supply bearings during starting and in case of oil- or water-supply failure. A water cooling coil in the tank keeps oil cool. Flow indicators in both oil and water lines give alarm in case of failure

OBITUARIES



HENRY SAMUEL DEMAREST, 71, president and treasurer of Greene, Tweed & Co., New York, N. Y., died at his home in Hempstead, N. Y., July 11. He had been associated with Greene, Tweed & Co. for over 37 years, and before 1900 had been connected with Worthington Pump & Machinery Corp.

Widely known in American and European power circles, Mr. Demarest was a member of the A.S.M.E., a vice-president of the Polish-American Chamber of Commerce, and had received from the Polish government the medal of the Order of Polonia Restituta.

JULIAN NEWTON, 70, president of the Providence Steam Trap Co., died suddenly at his home in Bristol, R.I., on June 13. He was born in England, and came to this country in 1881.

JAMES WALLACE TOWER, a partner in Hardy S. Ferguson & Co., consulting engineers of New York, died June 21.

FREDERIC G. RODIN, 51, assistant treasurer of Lumsden & Van Stone Co., Boston, Mass., and a member of its organization for 25 years, died at his home in Boston June 26.

AMBROSE SWASEY, 90, co-founder of the Cleveland firm of Warner & Swasey, makers of precision instruments for over 50 years, died at his summer home in Exeter, N. H., June 15. Dr. Swasey, often called the "Wizard of Precision," built many giant telescopes and gunsights, range finders, etc., for the Government. He held many coveted honors, including the Hoover gold medal, the Washington Award of the Western Society of Engineers, the Franklin medal, the John Fritz gold medal, one of the highest honors bestowed by the engineering profession in this country, and was a past president of the A.S.M.E.

COL. HUGH L. COOPER, 72, pioneer hydroelectric engineer who designed and supervised construction of the Wilson Dam at Muscle Shoals and the Dnieprostroy Dam and power station in Russia, died at his home in Stamford, Conn., June 24. Colonel Cooper was one of the outstanding authorities on hydroelectric engineering, and in the past 45 years had designed projects producing more than 2,000,000 hp. in the U.S., Canada, Russia, Chile, Mexico and Egypt.

PERSONALS

H. B. ALLEN, for 14 years New York district sales manager for Babcock & Wilcox Tube Co., has resigned to become vice-president of J. B. Astell & Co., Inc., 90 West Broadway, N. Y., N. Y.

H. J. MAUDERER, since 1924 assistant auditor of Westinghouse Electric & Mfg. Co., was recently elected auditor.

JOSEPH O'CONNOR, former president of Kieley & Mueller, Inc., New York, N. Y., has returned as president of this company after an absence of two years, during which he was head of a large textile concern.

GEORGE J. WYROUGH has joined the engineering staff of Thermoid Co., Trenton, N. J. Mr. Wyrough will be assigned to production and product-development work on belting, hose and packings.

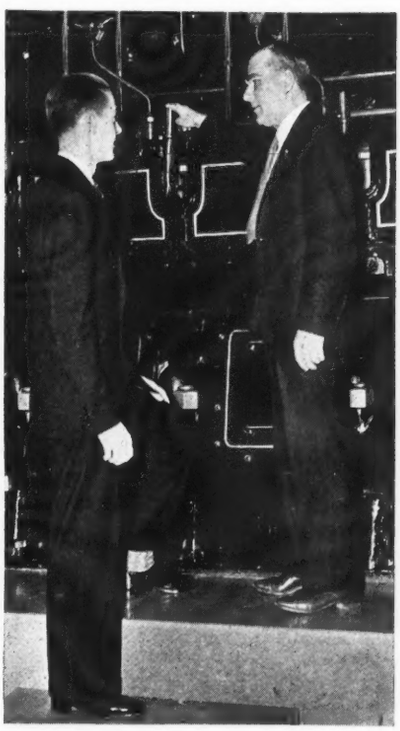
ROBERT S. SAYRE was recently appointed manager of Fuller Co.'s Chicago office. Mr. Sayre has been employed with Fuller Co. for a number of years at its home office in Catasauqua, Pa.

WILLIAM PRINTZ has been promoted to sales manager of the Eastern Div. of Wheelco Instruments Co., Chicago, Ill. Mr. Printz's headquarters are at 45 West 34th St., New York, N. Y.

JAMES A. GIBBONS has joined the field sales staff of Hancock Valve Div. of Consolidated Ashcroft Hancock Co., Bridgeport, Conn. Mr. Gibbons will specialize in industrial power-plant and public-utility construction work.

YOU SEE, IT'S THIS WAY

Chief Engineer Warren D. Lewis of the Hotel New Yorker in New York City explains to J. F. Walters, winner of the "manager for a day" contest among 1,700 New Yorker employees, operation of one of the two diesels (this one a 750-hp. engine) in his plant



D. D. PENDLETON, for many years associated with Foster Wheeler Corp., has resigned as their Pittsburgh district manager and has opened an office at 2418 Koppers Bldg., Pittsburgh. Mr. Pendleton is arranging to act as manufacturers' agent in the oil-refinery and power-plant fields.

ROBERT W. LAW has been appointed Boston division manager of A. M. Byers Co., Pittsburgh, succeeding J. J. Riley.

DONALD C. BAKEWELL has resigned as vice-president and chairman of the executive committee of the Continental Roll and Steel Foundry Co., in which capacity he has served since 1920, to become special representative and a vice-president of Blaw-Knox Co. He will make his headquarters at Pittsburgh.

BUSINESS ITEMS

TERRY STEAM TURBINE Co., Hartford, Conn., has appointed the following district representatives: Walter Cooke, 846 Baronne St., New Orleans, La.; Cowles & Co., 509 Mercantile Bldg., Dallas, Tex.; M. N. Dannenbaum Co., 202 Petroleum Bldg., Houston, Tex.; W. V. C. Jackson, National Bank of Texas Bldg., Tulsa, Okla.

WHITTLE HOSE & RUBBER Co., 549 W. Randolph St., Chicago, has been appointed representative for New York Belting & Packing Co., Passaic, N. J.

MERCOID CORP., Chicago, Ill., has transferred Bassett Lerch from its home office to St. Louis, Mo., and has appointed Russell MacDonald to its Boston office and Paul J. Provost to its Philadelphia office. Also, it has appointed Loeffler-Greene Supply Co. representative in Oklahoma City, Okla.

WARD LEONARD ELECTRIC Co., Mt. Vernon, N. Y., has appointed the following sales representatives: John S. Clark, El Paso, Tex.; Triangle Equipt. Co., New York, N. Y., and Chicago, Ill.; and Brance-Krachy Co., Inc., Houston, Tex.

NICKERSON MACHINERY Co., Salt Lake City, Utah, has been named representative by Allen-Bradley Co., Milwaukee, Wis., in Utah, southern Idaho and western Wyoming.

AJAX FLEXIBLE COUPLING Co., Westfield, N. Y., has appointed Roloff Engrg. Co., 610 W. Michigan St., Milwaukee, Wis., as sales representative for Milwaukee and surrounding territory. The company has also added three new sales offices at Akron, Ohio, Kansas City, Mo., and Seattle, Wash.

ACME EQUIPT. Co., representing Cyclone Grate Bar Co., Buffalo, N. Y., Kroeschell Boiler Co., Racine, Wis., Osgood Co., Marion, Ohio, and McLanahan & Stone Co., has moved to new quarters at 4525 W. Chicago Ave., Detroit, Mich.

GARLOCK PACKING Co., Palmyra, N. Y., this year celebrates its 50th anniversary as a manufacturer of mechanical packings. From a handful of employees, the company has grown to an organization employing over 1,000 employees and has three branch factories in this country and one in Canada.

STRAWS

Pointing the way business winds blow

ARIZONA——Arizona Light & Power Co., Phoenix, will build pipeline for gas distribution. Cost close to $35,000.

CALIFORNIA——Southern California Gas Co., 810 South Flower St., Los Angeles, plans 1-story and basement mechanical-blower station, 48 x 60 ft., on South Raymond Ave., Pasadena. Cost about $50,000. W. R. Shettell, construction engineer.

National Ice & Cold Storage Co., 417 Montgomery St., San Francisco, plans 1-story ice-manufacturing and refrigerating plant on W. Rhode Island Ave. Cost about $60,000. J. M. Smith, 251 Kearny St., San Francisco, engineer.

Richfield Oil Corp., 555 South Flower St., Los Angeles, plans power house and pumping station at oil-refining plant at Watson, near Los Angeles. Cost about $5,000,000.

Chico Ice & Cold Storage Co., Chico, plans 1-story precooling plant. Cost about $45,000. Walen Cearley, manager.

COLORADO——La Junta plans municipal electric plant, to cost over $100,000. Bond issue soon.

Holly Sugar Corp., Colorado Springs, plans power house at new beet-sugar mill at Hardin. Also pumping station for water supply and air-conditioning system in all main mill units. Cost about $1,500,000.

CONNECTICUT——New York, New Haven & Hartford R. R. Co., Water St., New Haven, plans coaling station at Springfield, Mass., to include conveying, loading and other mechanical-handling equipment. Cost close to $35,000. E. E. Oviatt, chief engineer.

FLORIDA——Florida National Building Corp., Miami, plans steam power station for central-heating and air-conditioning system in 16-story office building at N. E. 2nd Ave. and 1st St. Cost about $2,500,000. Marsh & Saxelbye, Hildebrandt Bldg., Jacksonville, architects.

J. Adams Bruce, 82 Columbia Dr., Tampa, heads project to construct and operate fruit-processing plant at Santa Rosa, Tex., to include boiler house and pumping station for water supply. Cost over $75,000.

GEORGIA——Macon contracted De Laval for turbine-driven pumping unit and auxiliaries for municipal waterworks.

IDAHO——Clearwater Valley Light & Power Assn., Inc., Lewiston, plans steam-electric generating plant in Latah County. Cost about $75,000. Financing through Federal aid.

Orofino plans motor-driven pumping plant for municipal waterworks, to be used largely for auxiliary service. Cost over $25,000.

ILLINOIS——Grandview will take bids soon for municipal water-softening plant. Cost about $80,000. Financing through Federal aid. Consoer, Townsend & Quinlan, 205 West Wacker Dr., Chicago, consulting engineers.

Sears, Roebuck & Co., W. Arthington St., Chicago, plans steam power station for central-heating service in new multi-unit department store at Highland Park, Detroit, Mich. Also to include an air-conditioning system. Cost about $7,000,000. Nimmons, Carr & Wright, 333 North Michigan Ave., Chicago, architects.

Springfield plans addition to municipal power plant at Lakeside, to include engine-generator unit, boilers, etc. Cost over $400,000. Burns & McDonnell Engrg. Co., 107 W. Linwood Blvd., Kansas City, Mo., consulting engineer.

INDIANA——Acme Engrg. Service, Inc., Fort Wayne, has applied to Federal Power Commission for permission to build three dams and two power plants on the Salomie River in Wabash and Huntington Counties. Proposed plans include a dam and power house to create a 60-ft. head of water, a second dam to create a secondary storage of 10 additional ft., and a third dam and power house to create a 25-ft. head.

Mutual Milk Co., 2243 Bethel Ave., Indianapolis, has let contract to E. B. Ball & Son, 1131 North Tacoma St., for 1-story boiler house at milk plant.

Vevay contracted A. D. Cook Co., Aurora, for turbine units and accessories and McGowan Co., Cincinnati, Ohio, for pumping machinery, for municipal power and waterworks station.

Haynes Stellite Co., Kokomo, has announced plans for a 2-story building, mainly for administration. Basement contract already let.

IOWA——State Board of Education, State House, Des Moines, plans improvements in power house at State College, Ames, including boiler units, pumping machinery and auxiliaries. Cost about $120,000. M. R. Pierson, secretary.

Rockwell City has asked bids for three 900-hp. diesel-generator units and accessories, oil tanks, cooling tower and auxiliaries. Cost about $175,000. Young & Stanley, Inc., Muscatine, consulting engineers.

Central Electric Federated Co-operative Assn., Pocahontas, contracted Commonwealth Electric Co., St. Paul, Minn., for three diesel-generator units, capacity about 2,750 hp., and auxiliaries, at $148,730, for power plant near Pocahontas. Cost about $193,000. Young & Stanley, Inc., Muscatine, consulting engineer.

State Board of Control, State House, Des Moines, plans extensions in power house at State School at Woodward, including boiler, engine-generator unit and accessories. $50,000 authorized.

Lake Mills contracted Fairbanks-Morse & Co., Chicago, for 450-hp. diesel-generator set for municipal plant.

State Board of Control of State Institutions, State House, Des Moines, has authorized $62,500 for boiler house at State Hospital, Cherokee. Work scheduled to begin soon.

KANSAS—Sedgwick plans municipal gas-distributing system. $25,000 authorized. F. E. Devlin, W-K-H Bldg., Wichita, consulting engineer.

KENTUCKY——TVA recently received Congressional approval to begin construction on $120,000,000 power dam at Gilbertsville.

Carrollton plans municipal gas plant and distributing system. Cost about $50,000. H. R. Lorch, mayor, active in project.

Somerset plans municipal electric plant. To make surveys and estimates of cost soon. W. C. Norfleet, mayor, in charge.

LOUISIANA——Monroe plans extensions in municipal electric station, including engine-generator units, boilers, pumps and auxiliaries. Also additions in waterworks and sewage systems. A bond issue of $1,500,000 planned for entire project.

MASSACHUSETTS——Buzzards Bay Water District, Buzzards Bay, will take bids soon for motor-driven pumping machinery; also for elevated steel tank and tower, pipelines and accessories. Whitman & Howard, 89 Broad St., Boston, consulting engineers.

Stone & Webster Engrg. Corp. has received a contract from M. I. T., Cambridge, Mass., covering engineering services and management of construction for new Architectural School building.

Simonds Saw & Steel Co., North St., Fitchburg, plans power house at plant, to include two diesel units and auxiliaries. Francis J. Sill, Westboro, consulting engineer.

MICHIGAN——Dow Chemical Co., Midland, plans filtration system for waste-water purification at industrial chemical works, including settling basin, 142-in. dia., two filtration basins of like size, pumping station, and pipelines. Cost about $250,000.

Citizens Light & Power Co., Adrian, plans cooling tower at local power plant. Cost about $25,000.

Zeeland contracted Peter Brill Co., Zeeland, for construction of municipal electric plant. Cost about $85,000, with equipment.

Southeastern Michigan Rural Electric Co-operative, Inc., Adrian, plans steam-electric generating plant for rural electrification system. $250,000 through Federal aid.

McClanahan-Leonard Pipe Line Co., Inc., Mount Pleasant, will build welded-steel pipelines from oil field in Buckeye Township, Gladwin County, to St. Louis and Alma, Mich. Thomas Russell, general superintendent.

Washtenaw Gas Co., Ann Arbor, and Michigan Gas Transmission Corp., United Artists' Bldg., Detroit, plan joint construction of 6-in. welded-steel pipeline from Carleton, Monroe County, to Ann Arbor, about 22 miles, for natural-gas transmission. Control and distributing station to be built at Ann Arbor.

MINNESOTA——Worthington Gas Co., will install generating unit and auxiliaries at artificial gas plant. Cost close to $60,000.

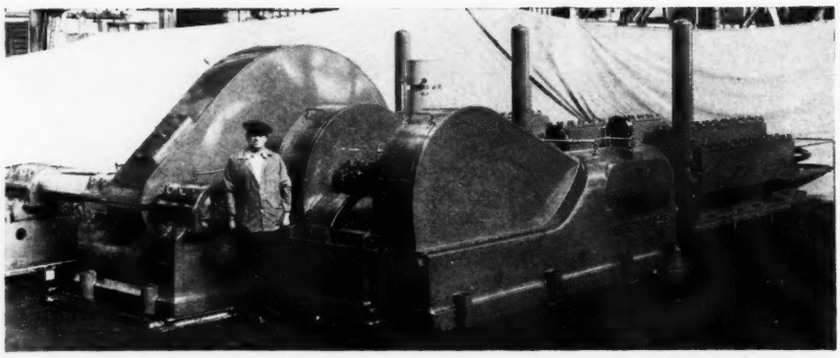
New Ulm contracted Power Service Corp., Minneapolis, for steam-generating equipment for municipal plant at $68,855, including B. & W. water-tube boiler, superheater, air pre-heater, stoker, forced-draft fan, induced-draft fan, soot blower, etc. Ralph D. Thomas & Associates, 1200 2nd Ave. S., Minneapolis, consulting engineers.

MISSOURI——Wabash Railroad Co., Railway Exchange Bldg., St. Louis, plans coaling station at Moberly, for capacity of 400 tons at one time, to serve four tracks. Cost about $50,000. J. C. Bousfield, company engineer.

Columbia contracted Westinghouse for one 5,000-kw. turbo-generator unit and accessories at $108,920 for municipal power plant; also, award to Elliott Co. for 7,000-sq.ft. surface condenser, at $34,052. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, consulting engineer.

MONTANA——Three Mile Fruit Growers' Assn., Florence, plans cold-storage and refrigerating plant for fruit-packing plant. Cost over $50,000.

NEBRASKA——Board of State Normal Schools, State Capitol Bldg., Lincoln, has asked bids for extensions in steam power plants at State Teachers' Colleges at Chadron, Wayne and Kearney, to include boiler units and auxiliaries. Cost over $75,000. Gordon Shattuck, Grand Island, architect.



WORLD'S LARGEST OIL PIPELINE PUMP

GOULDS PUMPS, Inc., Seneca Falls, N. Y., is shipping to the Southwestern oil fields this oil pipeline pump, said to be the world's largest. The huge horizontal triplex double-acting plunger-type pump has a 38-in. stroke and weighs about 75 tons. Capacity is 58,000 bbl. of oil per day.

Union Pacific Railroad, Omaha, has awarded contract for complete air conditioning of its 12-story home office at a cost of about $250,000. When completed, the U. P. building will be largest fully air-conditioned building west of the Mississippi.

Arnold is closing arrangements for purchase of local electric power plant. Improvements are planned. Bond issue being arranged.

NEW MEXICO——Lordsburg plans steel-pipeline distributing system for natural-gas distribution. Cost about $44,000. Financing through Federal aid.

NEW YORK——Carrier Corp., Newark, N. J., recently purchased at auction former plant of Franklin Automobile Co., Syracuse. It is expected that 80% of administrative and production operations of Carrier will be shifted to Syracuse within a year.

NORTH CAROLINA——Carolina Aluminium Co., 801 Gulf Bldg., Pittsburgh, has filed intention with Federal Power Commission to build dam, reservoir and power house, with installed capacity of about 54,000 hp., on the Yadkin River, near Tuckertown.

Winston-Salem plans central-heating plant in 4-story city hospital, for which $350,000 has been arranged. Northrup & O'Brien, Reynolds Bldg., Winston-Salem, architects.

Rocky Mount plans extensions in municipal electric plant. Also will make improvements in waterworks station. Bond issue of $500,000 being arranged.

State Building Commission, Capitol Bldg., Raleigh, plans central-heating plant in new multi-story state office building. $675,000 authorized. Northrup & O'Brien, Reynolds Bldg., Winston-Salem, architects.

NORTH DAKOTA——Gamble-Robinson Co., 24 First St., N. E., Minot, plans cold-storage plant in 3-story and basement building. Cost over $85,000. T. D. McMahon, Railroad Bldg., St. Paul, Minn., architect.

OHIO——New Boston plans motor-driven pumping station, filtration plant, and pipelines for waterworks system. Cost about $250,000.

Industrial Rayon Corp., West 98th St., and Walford Ave., Cleveland, plans steam-electric generating station, motor-driven pumps for water supply and air-conditioning system in mill buildings at Painesville, Ohio, for which general construction contract has been let to Hunkin-Conkey Construction Co., 1740 E. 12th St., Cleveland. Cost $7,500,000. Wilbur Watson & Associates, 4614 Prospect Ave., Cleveland, architects and engineers.

Columbus has asked bids for water-tube boiler and auxiliaries, stokers, etc., for municipal power plant. Cost about $250,000. Robert Tucker, superintendent of electrical department, in charge.

Harshaw Chemical Co., 1945 E. 97th St., Cleveland, contracted Mark Swisher, 1935 Euclid Ave., Cleveland, for 1-story boiler house, 37 x 40 ft., at chemical plant. Cost close to $40,000.

Galion has asked bids for extensions in municipal electric plant. William C. Kammerer & Associates, Smythe Bldg., Cleveland, consulting engineers.

Hamilton has asked bids for alterations in municipal electric plant. Cost estimated over $75,000.

OKLAHOMA——Oklahoma Pipe Line Co., National Bank of Tulsa Bldg., Tulsa has authorized new 6 and 8-in. welded-steel pipeline from Moore to Oklahoma City, about 12 miles, for oil transmission. Cost close to $90,000.

Tulsa Portland Cement Co., 1537 East Admiral Pl., Tulsa, W. L. Harris, president, plans power house at proposed cement mill. Cost about $150,000.

Phillips Petroleum Co., Bartlesville, plans power house compressor station and pumping plant at natural gas plant near Goldsmith, Tex. Plant will be equipped to process 50,000,000 cu. ft. of natural gas per day. Welded-steel pipeline will be built for transmission to plant. Cost close to $1,000,000.

OREGON——Hood River Apple Growers, Assn., Hood River, plans 5-story cold-storage and refrigerating plant, to be 36 x 160 ft. To cost over $125,000. H. P. Henschien, 59 E. Van Buren St., Chicago, Ill., architect and engineer.

PENNSYLVANIA——York Ice Machinery Co., York, has obtained contracts for air conditioning Ford branch assembly plants in Memphis, Tenn., and St. Paul, Minn. Four other branch assembly plants have already been air conditioned by York: Somerville, Mass., Chester, Pa., Edgewater, N. J., and Kansas City, Mo.

Cleveland Wrecking Co., Cincinnati, Ohio, recently purchased most of power-plant equipment of former Stewart Silk Co., Easton. Included were two 5,000-sq.ft. boilers, stokers, coal-loading equipment, centrifugal pumps, fans, etc.

Keystone Pipe Line Co., 260 S. Broad St., Philadelphia, contracted Jones & Hanrahan, Dallas, Tex., for 8-in. welded-steel pipeline from point near Williamsport to site on Lake Erie, near Buffalo, N. Y., about 213 miles, for gasoline transmission. To include bulk-storage and distributing plant at Buffalo. Cost about $1,700,000. Award has been made to National Tube Co., Pittsburgh, for steel pipe.

SOUTH DAKOTA——State Board of Charities and Corrections, State House, Pierre, has asked bids for extensions in power house at State Sanatorium, Sanator, including 125-kw. engine-generator unit and auxiliaries. D. W. Loucks, State House, Pierre, state engineer. Charles A. Trimmer, Madison, consulting engineer.

TENNESSEE——Memphis Natural Gas Co., Memphis, contracted A. M. Lockett & Co., Q. & C. Bldg., New Orleans, La., for booster station on natural-gas pipeline at Lula, Miss., comprising engine house, compressor and pumping station, and office building. Cost about $200,000, including equipment. Also plans similar booster station of smaller capacity for pipeline system at Wilmot, Ark., to cost about $80,000.

TEXAS——Humble Oil & Refining Co., Houston, plans power house and compressor plant at natural-gasoline plant in Galveston County. Welded-steel pipeline will be built for transmission to plant. Cost about $250,000.

New Caney plans power house and pumping station for drainage system. Cost about $30,000. Ray F. Jones, Houston, consulting engineer.

Palmetto Co., Harlingen, plans welded-steel pipeline from El Tanque to Harlingen, for crude-oil transmission. Bulk-loading and distributing plant to be located at latter place. Cost over $100,000.

Shell Petroleum Corp., Shell Bldg., St. Louis, Mo., plans 6-in., welded-steel pipeline and booster stations from McCamey to Goldsmith, about 50 miles, for crude-oil transmission. Cost over $350,000.

G. W. Fraser, 8 Cedar Lawn Circle, Galveston, plans power house at cottonseed-oil mill at Corpus Christi. Cost about $300,000.

Engleman Gardens Assn., Edinburg, plans boiler house at citrus fruit-packing dehydrating plant. Cost about $100,000.

Roeser & Pendleton, Fort Worth Club Bldg., Fort Worth, plans power house and compressor station at natural-gasoline plant near Albany, to include engine and compressor units to handle about 2,000,000 cu. ft. per day. Cost close to $100,000. P. W. Armstrong, plant engineer.

VIRGINIA——Northern Neck Electric Co-operative, Inc., Warsaw, plans steam-electric generating plant for rural electrification system. Fund of $184,000 through Federal aid.

Shenandoah Valley Electric Co-operative, Inc., Harrisonburg, contracted Central Armature Works, Inc., 625 D St., N. W., Washington, D. C., for diesel-generator unit auxiliaries at $71,095.

WASHINGTON——Orcas Power & Light Co., East Sound, plans steam-electric generating plant. Fund of $87,000 through Federal aid.

WASHINGTON, D. C.——Doctors' Hospital, Inc., 1801 I St., N. W., plans central-heating plant in multi-story hospital building on I St. Cost about $1,000,000. Francisco & Jacobus, 511 Fifth Ave., New York, N. Y., architects.

WISCONSIN——Board of Trustees, Mount View Sanatorium, Wausau, plans steam power house at institution. Cost over $45,000, with equipment. Oppenhamer & Obel, Wausau, architects; H. H. Hay, 4115 N. Stowell Ave., Milwaukee, consulting architect.

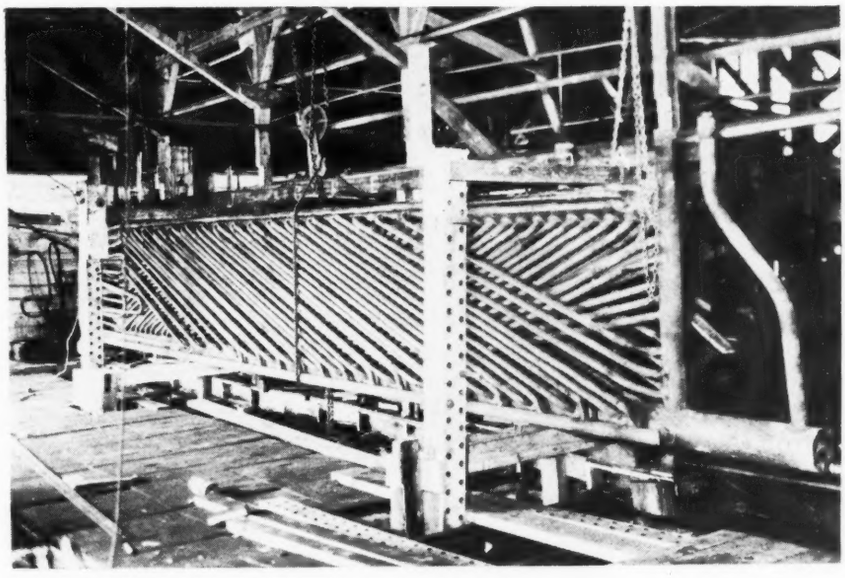
Marshfield contracted A. R. Robertson Co., 1593 University Ave., St. Paul, Minn., for extensions in municipal power plant, including boiler unit and auxiliaries. Cost over $50,000. Helmick, Edeskuty & Lutz, Essex Bldg., Minneapolis, consulting engineers.

ALASKA——Seward contracted Bennett & Taylor, 1041 Venice Blvd., Los Angeles, Calif., for construction of municipal power plant, including diesel engine generator unit and auxiliaries, at $92,637. Hubbell & Waller Engrg. Corp., Alaska Bldg., Seattle, Wash., consulting engineer.

CANADA——Winnipeg Hydroelectric Co. has awarded contracts to Dominion Engrg. Co. for a turbine at $97,500 and to Swedish General Electric Co. for generator at $141,655 for its Slave Falls plant.

HODGE-PODGE OF TUBES

A MISCELLANEOUS mixture of tubes becomes an ammonia evaporator unit for an ice tank at the Rierson Brothers Welding Works, Greensboro, N. C. It was built by joining five different sizes of pipe together with shielded-arc electric welding equipment supplied by Lincoln Electric Co., Cleveland, Ohio



PRETTY PLANT

One day, Old Doc Felters, our hometown vet, was giddapin' his way out to his farm when Miz Shanner called him in. Sez she, "Doc, my cat's sickern tarnation, and I don't know what to do fer him."

"We-e-ll," says the Doc, "I confess I don't know nuther. If that cat was a horse, now, I'd give him about a pint of salts. Was he a cow, I'd make it a quart. But I'm dogged if I know how much to give a cat!"

"Doc," says Miz Shanner, "Nothin' you'd do could make that cat any sicker. I suggest you give him the quart." The Doc, shakin' his head, did it.

Next day when he passed Shanner's place, he saw about a dozen visitin' cats in in the back yard. Eight of those extry cats was busy diggin' holes, and four was busy coverin' 'em up. But, after that Shanner cat got over his astonishment, he lived to a ripe old age. Now the Doc has standardized—a quart of salts for man or beast, regardless.

Standardization has its virtues. At least you have something to go on—you're not always experimenting. To my mind there's nothing as standard as one of those small buildings they used to have out back of the house. Yet, we had a feller named Barney in our town that was forever trying innovations. Once it was a sliding door that stuck every time somebody was in a hurry. And another time he built one on wheels so it could be moved, and a windstorm blew the whole thing right down Main Street into the milliner's shop, with the owner in it too. For two weeks afterward, that feller was looking for Barney with a shotgun.

It just shows you can go too far in any experimenting, and when it isn't justified, it costs a lot more than it's worth. I saw a new boiler plant the other day, with everything special. Chief was darn proud of it too; said he'd designed most of it himself. But wait 'till he begins to find the grief he designed into it at the same time!

I suppose he'd heard or read of the fanciness the big plants put in, and forgot that they have more money to spend and usually know pretty well why they're spending it. For them, with specialists to keep everything tip top, prettiness is practical. But all this Chief has is an ordinary boiler-room crew.

Besides his special orders made him wait six months extra for his new plant, which, any way you figure it, is just six months of potential savings gone up the stack. He'd have done better to give equipment makers credit for the years they've spent developing parts. They've gone through all the grief with every new idea, ironed out the kinks, and produced something that stands the gaff.

Of course, there'd be a lot of other people with valves and auxiliaries just like his. But what of it? For the satisfaction he gets out of a "one-design" plant, he spends hours of extra time ironing out his own kinks all over again. He's got special-shape gages and meters, fancy controls, trick valves and a lot of outside fanciness—but how about performance?

His special boiler will probably deliver steam enough cheaper to pay back what it cost him, but most of the extra tricks won't. It's one thing to get highest possible performance out of a plant, and another just to throw money away.

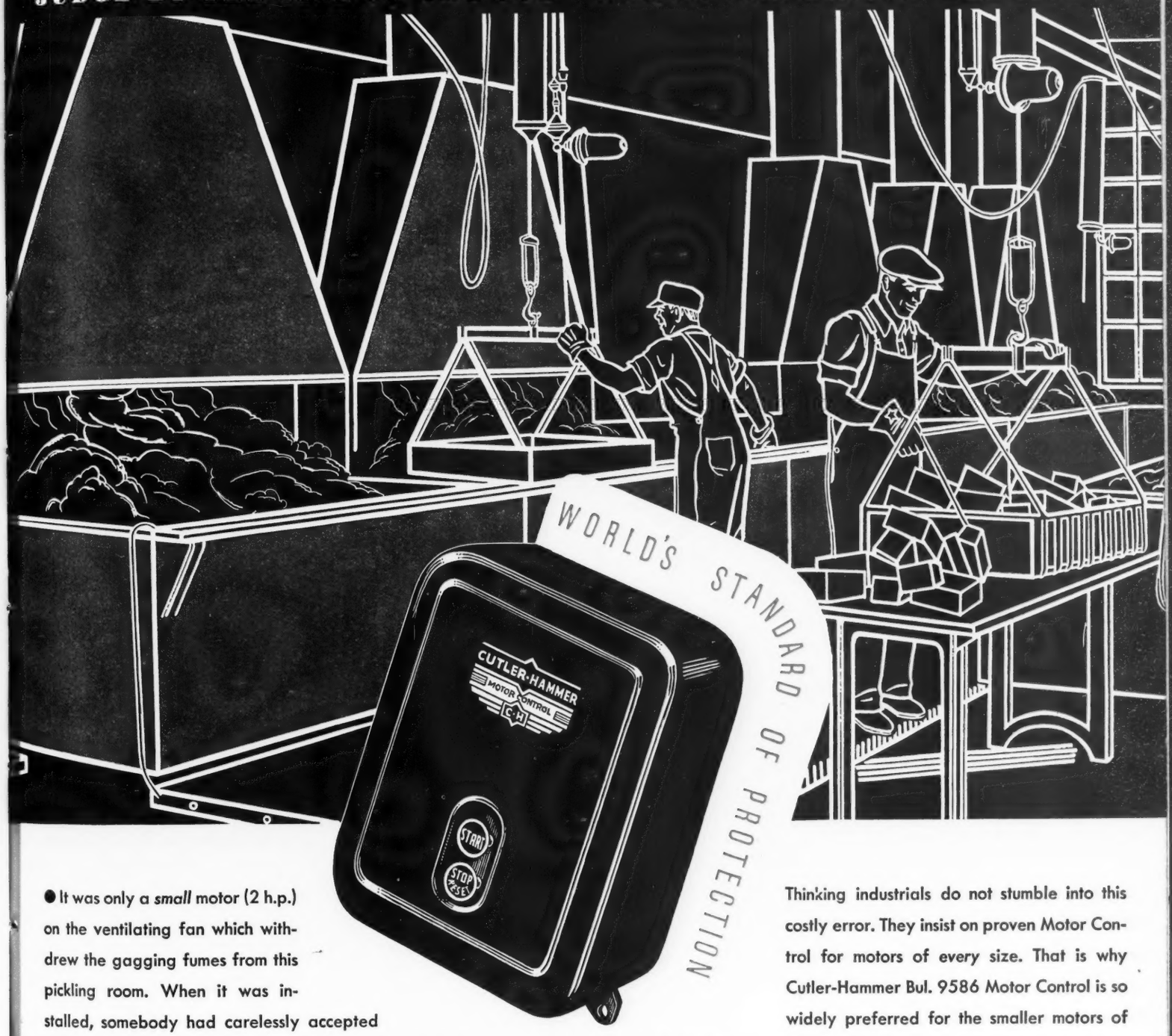
It's worth thinking about. Balance what a new design costs against what it's going to do for you—and how soon. If you're honest with yourself that'll give the answer. In performance, just prettiness alone isn't enough.

George Edwards

GEORGE EDWARDS.
Engineer

A SMALL MOTOR MAY CHOKE AN ENTIRE FACTORY

JUDGE BY THE SIZE OF THE JOB · NOT BY THE SIZE OF THE MOTOR



● It was only a *small* motor (2 h.p.) on the ventilating fan which withdrew the gagging fumes from this pickling room. When it was installed, somebody had carelessly accepted inferior Motor Control, never recognizing the importance of the installation. When the motor failed and the fan stopped, it took more than an hour to restore normal operations. The price of a careless attitude toward the importance of *small* motors and their Motor Control is too high to hazard.

FOR SMALL MOTORS

Built to a standard of millions of operations with heavy solid silver twin-break contacts and the famous C-H eutectic alloy overload relay. Featured as standard equipment by responsible machinery builders and stocked by reliable independent electrical wholesalers. Cat. 9586 AAA.

CUTLER-HAMMER
MOTOR CONTROL
C-H

Thinking industrials do not stumble into this costly error. They insist on proven Motor Control for motors of *every* size. That is why Cutler-Hammer Bul. 9586 Motor Control is so widely preferred for the smaller motors of Industry. Its many features of superior construction, its legacy of the widest engineering experience and its unequalled record of performance *must* recommend it to you. CUTLER-HAMMER, Inc., *Pioneer Manufacturers of Electric Control Apparatus,* 1358 St. Paul Ave., Milwaukee, Wis.

NEW BULLETINS

Automatic Lubricating System—Bijur Lubricating Corp., Long Island City, N. Y. 16-page Bulletin D on centralized, force-feed automatic lubricating devices, including "Meter-Unit", and three other types of lubricators. Photos show typical applications and hook-up methods.

Fabricated Processing Equipment—Edge Moor Iron Works, Edge Moor, Del. 8-page Bulletin No. 103 lists complete line of process equipment made from rolled and forged metals with description and application of various units, including air preheaters, water-tube boilers, heat exchangers, etc.

Magnetic Brake—Stearns Magnetic Mfg. Co., Milwaukee, Wis. Bulletin 600 describes Type DM magnetically operated brake which operates either floor or motor mounted through a keyed shaft, geared directly to operating elements of brake. Application photos and specifications.

Steam Turbines—De Laval Steam Turbine Co., Trenton, N. J. 4-page reprint from *Steel*, Sept., 1936, written by C. R. Waller, De Laval vice-president in charge of engineering, entitled "Power and Heat Problems Yield to Improved Alloys and Designs." Discusses recent improvements in design and materials used in steam turbines.

Suspended Magnets—Stearns Magnetic Mfg. Co., Milwaukee, Wis. Bulletin describes various types of safety suspended circular, rectangular, and hand magnets, together with illustrations and application data.

Oil Circuit Breakers—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Descriptive Bulletin 33-226 on construction, operation and application of Type F-124 indoor oil circuit breakers for industrial and central-station use. Breakers rated at 50,000 kva. interrupting capacity, manually and electrically operated, non-automatic and automatic, single throw.

Grilles and Doors—Cornell Iron Works, Inc., 36 13th St., Long Island City, N. Y. 12-page catalog, "Modern Cornell Doors—Upward Acting," describes and illustrates upward-acting doors and grilles, rolling doors and grilles in various metals, and wood and steel float-over, canopy, bifold, vertical-lift, and turn-over doors. Shows unusual applications.

Air Circulation—Kisco Co., Inc., 4414 W. Papin St., St. Louis, Mo. 32-page catalog, "Breezy Tales of Summer Sales," shows complete line of Kisco air circulators and fans with typical applications and installations for industrial and commercial buildings.

Circuit-Testing Ohmmeter—James G. Biddle Co., 1211 Arch St., Philadelphia, Pa. Bulletin 1495 on "Megger" circuit-testing ohmmeter, a cross-coil type said to be independent of voltage of operating battery. Measures resistances from 0.1 to 200,000 ohms.

Extraction Steam Heaters—Griscom-Russell Co., 285 Madison Ave., New York, N. Y. 12-page bulletin 277 describes recent developments made in G-R Type L extraction steam heater which is said to have eliminated heavy bolts ordinarily required for high-pressure service and to prevent leakage between passes. Also describes two new baffles incorporated in this unit.

Electrode Holder—Lincoln Electric Co., Cleveland, Ohio. Mailing folder on Type T and Type HT heavy-duty holders.

Welding Instruction—Lincoln Electric Co., Cleveland, Ohio. 10-page bulletin, "Building a Career in Arc Welding," describes Lincoln training school and course and how to go about enrolling.

Steam Generators—Riley Stoker Corp., Worcester, Mass. Catalog on water-tube boilers, water-cooled furnaces, superheaters, air heaters and economizers. Very elaborately illustrated with 3-color drawings and photographs, line cuts and tables. Sections also show typical installations and manufacturing process.

Electric Heaters—General Electric Co., Schenectady, N. Y. 60-page Catalog GED-650 lists small heating units, including immersion heaters, cartridge units, strip heaters, calrod units, unit heaters, etc. Also control equipment.

"Trans-O-Meter"—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Catalog section No. 43-770 describes portable device for measuring transmittancy of flat materials on direct-reading instrument. Shows application, operation, specifications, and prices.

NEW PLANT CONSTRUCTION

McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service

Ark., Fort Smith—Oklahoma Gas & Electric Co., 32 North Harvey St., Oklahoma City, plans constructing 33,000 volt electric substation. $25,000 appropriated. Byllesby Eng. Co., 231 South LaSalle St., Chicago, Ill., engrs.

Calif., Alturas—Surprise Valley Electrification Corp., Alturas, surveys being completed to provide electric power for rural communities in Modoc and Lassen Counties, Calif., and Lake Co., Ore., will involve in the main a 900 hp. diesel-electric plant and approximately 350 mi. transmission and distribution lines. A Sickler, Alturas, engr.

Calif., El Centro—Imperial Irrigation Dist., voters at special election June 16, approved District's participation in government contracts providing for P.W.A. loan and grant of $2,760,000 and R.E.A. loan of $700,000 for financing project. Plans and specifications are being prepared and bids will be called soon on first units of a new hydro-electric plant on the All-American Canal, additions to existing diesel plant at Brawley, transmission lines and miscellaneous plant equipment. Total est. $3,500,000. M. J. Dowd, c/o owners, engr.

Ill., Springfield—City, J. Knapp, mayor, making plans consrtucting power plant addition for another generator with boilers. Est. about $400,000. Burns & McDonnell, 107 West Linwood St., Kansas City, Mo., engr.

Ind., Whiting—Globe Roofing Products Co., A. Cobourn, pres. 176 West Adams St., Chicago, Ill., plans 40x304 ft. factory, 45x93 ft. storage building, 40x100 ft. warehouse, 65x320 ft. all 1 story finished goods house, boiler house, four 21,000 gal. asphalt stills, 20,00 gal. fuel oil tank, machine shop, B. & O. Ry. and Schrang Ave. Site selected. Private plans.

Ia., Burlington—City plans furnishing, installing new pumping unit for waterworks to be steam driven turbine centrifugal pump. $20,000. Approved by City Council. F. Lawler, supt.

Ia., Cherokee—Iowa Public Service Co. plans constructing power plant. $125,000.

Ia., Pocahontas—Central Electric Co-Operative Assn., plans constructing and equipping generating plant. REA approved $75,000 allotment. Young & Stanley, Muscatine, engrs.

Ia., Waverly—City plans by Young & Stanley, engrs. and archts., Muscatine, constructing 47x54 ft. electric light plant addition and installing diesel powered generators. $184,500.

Kan., Moundridge—Continental Oil Co., Ponca City, Okla., and Fair Bldg., Fort Worth, Tex., plans gas engined electric light and power plant. $75,000.

Kan., Topeka—Hill Packing Co., foot of Jefferson St., plans survey of packing plant to determine details of power and heat production; may build central plant. B. W. Friedel, 1152 Washburn St., Topeka, archt.

Me., Lewistown—City, G. Z. Bernier, supt. Water Dpt., City Hall, making plans municipal pumping and street lighting power plant, additions and alterations to present pumping station, water wheels, raceways, pumps, generators and diesel engines, To generate all power for water pumping and street lighting. $228,000. Application made to P.W.A. for 45% grant. Whitman & Howard, 89 Broad St., Boston, Mass., engrs.

Mich., Kalamazoo — City Government voted to have plans prepared for electric light plant, extensions and addition, incl. installation of 2,000 kw. generator with appurtenances. $265,700. Burns & McDonnell Co., 107 West Linwood Blvd., Kansas City, Mo., engrs.

Mich., Pontiac—City plans municipal electric plant, incl. three oil burning diesel engines, other machines, panels, wires and distributing apparatus.

Minn., Adrain — City, F. J. Forkenbrock, clk., furnishing, installing diesel power unit for municipal electric power plant. To exceed $40,000. Druar & Milinoswki, 830 Globe Bldg., St. Paul, engrs.

Minn., Lake Crystal—City, G. W. Champlin, clk., rejected bids opened Mar. 29, power house and equipment, electric distribution system. $90,000. G. M. Orr & Co., 542 Baker Arcade Bldg., Minneapolis, engrs.

Minn., New Ulm—Bids Aug. 3, by City, A. S. Sannwald, clk., constructing power house extension and changes, auxiliary equipment. incl. surface condenser, water feed and auxiliary items. $35,000. R. D. Thomas & Associates, 1200 2nd Ave. S., Minneapolis, engrs.

Mo., Rock Port — City, J. R. Bailey, clk., plans municipal light and power plant, incl. generating equipment, switchboard, station wiring, etc. $90,000 bonds voted. Seeking P.W.A. grant. Will endeavor to purchase local distribution system from Missouri Pub. Serv. Comn. Engineering Service Co., Exchange Bldg., Kansas City, Mo., engrs.

Neb., Omaha—Nebraska Power Co., 17th and Harney Sts., constructing brick, concrete building for power plant, 27th and Q Sts., to Phoenix Eng. Co., 2 Rector St., New York, $1,000,000 cost plus basis. New equipment to be purchased. C. Minard, c/o owner, ch. engr.

Neb., Spencer—Interstate Power Co., Dubuque, Ia., checking with Nebraska Railway Comn. as to value of Northern Nebraska Power Co. plant near here which was put out of commission less than 1 year ago when concrete dam gave way. Interstate has option on this plant at $60,000 and plans to spend $190,000 to put it back in operation provided they find that it would be worth while. E. A. Wisco, c/o owner, operating engineer.

N. J., Trenton—E. F. Fisher, gen. mgr., Fisher Body division of General Motors, plans 1 and 2 story plant for manufacture hardware and metal interior trimmings for closed auto bodies, along Reading R. R. Will also erect power plant. Est. to exceed $5,000,000.

N. M., Lake Arthur—Central Valley Rural Cooperative Electric Co. plans constructing generating plant. $60,000; 84 mi. transmission lines. $104,000; to service 134 customers in Eddy and Chaves Counties. REA allots funds.

N. C., Tuckertown—Carolina Aluminum Co., Gulf Bldg., Pittsburgh, Pa., and Badin, N. C., plans dam and hydro-electric plant near Tuckertown on Yadkin River, dam 1,300 ft. long x 90 ft. high concrete and will create lake covering 3,050 acres in Stanly, Montgomery and several other counties adjoining, capacity of plant 50,000 hp. Work will be under supervision of company, S. A. Copp, genl. supt.

O., Cincinnati — Chevrolet Motor Co., 472 Smith Rd., plans power plant improvements. $250,000.

O., Findlay—Central Ohio Light & Power Co., Findlay, soon takes bids steam electric power plant. To exceed $1,000,000. Sargent & Lundy, 140 South Dearborn St., Chicago, Ill., engr.

O., Painesville—City plans enlarging and improving present municipal light plant, incl. new boiler and turbine, $415,000. C. S. Fullerton, city mgr. and engr. H. R. Hadlow, consult. engr. retained to make survey of plant.

O., St. Marys—City soon takes bids extending and enlarging municipal electric light and waterworks plant and systems by installation 250 lb. steam generating unit, incl. stoker, soot blower, force draft fan, superheater and guide stack and constructing addition to boiler room of plant, installation steam and feed water piping and accessories, and control apparatus. Council appropriated $51,000 and approved plans submitted by C. F. Lambert, St. Marys, consult engr.

O., Warren—Public Service Co., Hanna Bldg., Cleveland, takes bids in August constructing generating plant. $2,500,000. G. E. Snider, Hanna Bldg., Cleveland, engr.

Pa., Scranton—General State Authority, Harrisburg, plans by J. J. Howley, 250 Wyoming Ave., laundry, garage and power house. $850,000.

Pa., West Pittsburgh (Lawrence Co.)—Pennsylvania Power Co., T. L. Paden, eng. dpt., 19 East Washington St., New Castle, plans by K. C. Kressbach, archt., 212 West Michigan Ave., Jackson, Mich., and G. C. Daniels, engr., Michigan Ave., Jackson, Mich., and soon lets general contract steam power plant, incl. transmission lines and substations, two 35,000 k-w. units two 400,000 lb. per hour unit. Stack for above, awarded to Rust Eng. Co., Clark Bldg., Pittsburgh. Total est. $2,800,000.

Utah, Monroe—Municipality plans electric light and power plant. $40,000.

Wash., Centralia—A. Goldschmidt has presented to City Comn. a proposed ordinance granting him franchise to construct and operate central heating plant. $100,000. Special election will be necessary to ratify franchise if city passes ordinance.

Man., Cranberry Portage—Gurney Mines, Ltd., plans constructing powerhouse and purchase equipment. $75,000. Engineer, c/o owner, eng.

Ont., Hamilton—Hamilton Hydro-Electric Comn., 12 King St. E., making plans constructing and equipping substation. $150,000. H. E. Murton, 4 South Hughson St., engr.

Ont., Schreiber—Ontario Paper Co., Ltd., Thorold (subsidiary of Chicago Tribune, Chicago, Ill.) making preliminary surveys near Heron Bay for electric power plant and dam. $375,000. Private plans.

Ont., Toronto — Ontario Hydro-Electric Comn., making plans installing additional power facilities in the Trent Valley plants to increase capacity. $470,000. This is in connection with recent purchase of the Campbellford and Frankford plants by Commission at price of $325,000.

Ont., Windsor—Municipality making plans extending hydro-station in order to increase capacity from 2,500 h.p. to 5,000 h.p. $40,000. O. M. Perry, mgr. of Hydro. of Windsor.

East Africa, Kenya, Kisumu—The Kisumu Power & Distribution Co. preparing plans generation station, distribution lines, etc. $1,000,000.

Siam, Bangkok—Ministry of Interior making plans generating plant of diesel engine type. $900,000. Bids to be called in August.